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INCANDESCENT LAMP COMPLICATIONS.

So Edison and Swan have made up their differences on the Continent, or so far as they relate to the greater number of Continental countries. That this is an act of wisdom few will question. The results of the amalgamation in England have been of such a character that it is not surprising to find the owners of the foreign patents following the English example. Germany still remains contested ground, but the probabilities are all in favour of the disputants there reconciling their differences in the same manner as the differences of the other companies have been reconciled. The effect of these settlements may be to avoid the determination legally of the great issue between the representatives of the two inventors, the question of priority. If this end be achieved we shall confess our gladness. Where the spectacle is presented of a contest for the upper hand between two men of great eminence who have each independently and as nearly as possible simultaneously worked out a problem of supreme industrial importance, it is almost painful to witness the success or the failure of one or the other. Both are entitled to the utmost credit, and each would probably admit the greatness of the other. Of course, many other persons and many other interests have come between the two principals, between whom there is probably now little in the nature of a direct conflict; but to the general view the fight is between Edison and Swan, and we repeat that it is a great pity that two such men, in the peculiar circumstances of this joint invention, should ever have fought at all.

The different manner in which the respective patents were disposed of by the inventors has led to some rather curious complications. In England there was an Edison Company and a Swan Company. The Edison Company held the Edison patents for Great Britain and Ireland; the Swan Company held the Swan patents likewise for the United Kingdom, but was also the possessor of the patents for all Continental countries in which patents were taken out with the exception of Spain. These two companies contracted an offensive and defensive alliance against all others in the United Kingdom. Mr. Edison's foreign patents fell into the hands of two separate parties, and with both these the Swan Company has been engaged in litigation. That litigation now ceases so far as regards all Continental countries but Germany. Whilst all around is peace the conflict still goes on in Germany, where another company than that which owns the rest of the Continental Edison patents holds sway. But a curious feature of this in-and-out affair is that Mr. Swan, at an early period, sold out and out his rights for Spain, and the Swan United Company therefore has no control over that country. But the Compagnie Continentale Edison does hold the Edison rights for Spain, and will include them in the arrangement which is being entered into with the Swan United Company. It will be interesting to learn in just what position Mr. Swan stands with regard to the imaginable state of things in Spain. At present it seems as if he stands to win most by doing all in his power to prove that he was *not* the true and only inventor; whilst in Germany, if the litigation continues there, it will be to his interest to prove the direct contrary. We say nothing of the position in England, which is puzzling enough in itself. There is no doubt as to priority in patenting in England, Edison having preceded Swan by somewhere about a month; but when opposed to Edison in this country, Swan alleged that the former's patent was insufficient in direction and description. Now that they have thrown their lots together against "the common enemy, the infringer," that enemy has sought to invalidate Edison's patent, not only by the allegation of insufficiency, but by urging prior publication by means of lectures by his now dear friend and partner, Swan. Needless to say, in the present stage of the litigation in our own Courts, we shall refrain from offering any remark or opinion upon the merits of the case as it is being placed before Mr. Justice Kay; but we may be permitted to say that, whatever may have been the material rewards Mr. Swan has reaped as the fruit of his inventiveness, he cannot reflect with any degree of pleasure upon his patent suit experiences.

IT is darkly hinted that a gentleman who is much in request when electric light contractors desire to know whether their installations have been carried out strictly within the terms of the fire office rules is strongly in favour of the employment of but one kind of insulated conductor. The special insulation is, we believe, produced by several companies, only one of which, however, seems to turn out the article precisely as it should be. Experts in the insulated wire trade have assured us that to them the difference in the class of materials—and, indeed, of the general get-up of the various specimens tendered as samples of a given lead—is unrecognisable; yet there appears to exist an indefinable something somewhere which eventually leads to the conclusion that in only one place can the covered wires be obtained which will satisfy the keen perceptions of this lynx-eyed guardian of the public weal. Trade jealousies may, perhaps, be at the bottom of all this, but we simply state that which has been brought to our notice as constituting a real grievance.

IT is pretty generally known amongst a certain class of electricians what result is to be expected from all known electrical and chemical combinations as applied to primary battery construction. The modern inventors of galvanic elements, or more correctly, the re-discoverers of abandoned projects, do not, however, in nine cases out of ten, possess any real knowledge on this most important point; therefore the paper of Mr. Crocker, which may be found in our other pages, may

be the means of giving them some very desirable information. Notwithstanding the position we have for years taken up with regard to primary batteries, it must not be supposed that we incline to the belief that no improvement will ever be possible. On the contrary, we think that very much may be done, nay, has been accomplished, in increasing the periods of time during which well-known types of primary batteries can be made to remain approximately constant. There are but few people who have had any practical experience with Bunsen elements who would give credence to the following data if not supported by authentic tests. Three cells were made up as Bunsen elements, with this exception, that the carbon in the porous pot was placed in a newly discovered depolarising solution, and not in ordinary nitric acid. The internal dimensions of the outer jars, which contained the zincs in a solution of 1 to 20 of sulphuric acid and water, are $8\frac{1}{4}$ inches × $8\frac{1}{4}$ inches × 12 inches deep. For 26 hours these three cells were kept in circuit with an ampèremeter, the current being adjusted in the first instance, by resistances, to about 10 ampères. The current varied only 5 per cent. during this time; the free potential (1·83 volts per cell) did not fall so much as 5 per cent.; and the working E.M.F. at the terminals, 3 volts at starting, had risen to 3·4 volts at the end of the trial, this rise being caused by the decreasing internal resistance of the cells which demanded the consumption of less electrical energy in the battery and allowed more to be utilised externally. The consumption of zinc, we may add, was but a small percentage above that demanded by theory.

A WRITER in the *Paper Trades Journal*, who appears to be specially engaged, says that there is one matter which millwrights must take up and learn, and that is electrical engineering. In less than 10 years, he prophecies, no man will be competent to become a foreman millwright in a paper mill if he is not acquainted with electrical engineering, and he goes on to state that it is a matter that can be learned at home by the evening fireside, and only a few dollars' worth of books need be purchased to obtain the desired information. The result of this method of procedure for becoming *au fait* with electrical engineering is summed up in the following remarkable statement which points to the immediate possibility of every man becoming his own electrical engineer:—"A man will soon learn that every yard of wire wound upon the armature of a dynamo should give 1 volt of 'electromotive force,' E.M.F., or E., as usually designated. He will also learn that the wire wound on a certain machine opposes a certain number of volts' (*sic*) resistance, R, to the passage of the electric current and which the E.M.F., or volts, must overcome. Lastly, it will be found that the E.M.F., divided by R., will give the quantity of electricity, C, which goes to maintain the lamps. Hence, if he knows the amount of wire on an armature, he can calculate the three measurements and tell just what any given dynamo will do. There are many wonderful things about electricity which render it extremely fascinating to the student, and are known as Ohm's law. The algebraic statement $C = \frac{E}{R}$ is the foundation of all electrical knowledge." The knowledge that we have lived till this simple announcement met our bewildered gaze is a source of extreme gratification to us, and we now feel that our long years of labour in the cause of the advancement of science have not been spent in vain. The dream of our life has been accomplished, and we feel that we can lay aside the pen since the problems connected with electrical engineering have been reduced to nothing, or to nothing more formidable than $C = \frac{E}{R}$. We have suddenly discovered that the *Paper Trades Journal* is a New York periodical, and this, we need scarcely add, places the matter in a new light.

IN the new edition of Sir David Salomons's work on accumulators is published a reprint of the recently issued rules of the Society of Telegraph Engineers and Electricians, compiled to reduce the fire risks incidental to electric lighting installations. Sir David ventures upon criticising some of these rules for the formation of which he was partly responsible, and we think that some of his comments are vastly more amusing than the rules themselves, and that the two combined detract considerably from the value which the volume would otherwise possess. He also poses as a censor upon the conduct of electric lighting companies and suggests in one breath stringent penalties for any breakdown, accidental or otherwise, and in another he calmly tells us that we must wait for the improvements which, now non-existent, are coming slowly but surely to make electric lighting reliable. Is not this a little inconsistent? Sir David further advocates the formation of a society called "the Electrical Association," managed by business men and one or two scientists, to which those desirous of becoming acquainted with every detail of electric lighting could confidently apply and for a small fee have all their little wants supplied. The goods sold through the agency of the Association, which is to be altogether beyond reproach and absolutely immaculate in its dealings, should bear a commission sufficient to pay the expenses of the directorate, and to allow for interest not exceeding 5 per cent. per annum. The author has been responsible for some very curious ideas at various times, and many of the suggestions contained in this, the latest edition of his book, could only be credited to Sir David Salomons. The little eccentricities with which its pages teem will, however, be apparent to the reader, and we shall therefore reserve our comments upon the useful portion of the book until a later date.

IN our issue of March 23rd appeared a notification of the registration of the Schanschieff Electric Light and Power Company, Limited. In the same number we commented upon the prospects of the company, and gave expression to the opinion that we had forebodings for the future, and it now appears that there was a certain amount of truth in our prognostications. We hear of various rumours afloat respecting the inner working of this venture, and we think it high time that something should now be made public to account for the delay in bringing the Schanschieff battery into the market. It would naturally be best that the directorate should give to our readers a plain unvarnished statement, for it will then be unnecessary for us to state our own views of the situation on the strength of information which has reached us.

ELECTRICIANS who have had practical experience in the manufacture and employment of insulated conductors, will probably question the value of Dr. John Hopkinson's electrical tests on "Okonite." The enormous length operated upon in one of the experiments —10 feet—is enough to raise doubts as to the reliability of his figures in the minds of those who have to deal with one and two mile lengths of core in practical work.

EXPERIMENTS IN STATIC ELECTRICITY WITH THE INCANDESCENT LAMP.

THE incandescent lamp is generally classed among the applications of dynamic electricity, and, practically speaking, writes Elmer E. E. Emmons in the *Scientific American*, it properly belongs there, but many who are interested in science may be interested to know that the incandescent lamp may also be classed with the apparatus for studying the phenomena connected with static electricity.

With an Edison lamp, two or three suspended pith balls, some fragments of light material, and a silk handkerchief, the two fundamental laws of static electricity may be demonstrated.

The lamp should be held by the small end and the glass bulb rubbed with the handkerchief and then presented to the substance experimented upon. The bulb should be heated slightly to dry it.

Now, if a lath is balanced on a point on the bottom of a round-bottomed bottle, it can be made to revolve by holding the rubbed bulb near one end. (Fig. 1.)

In fact, any experiment that can be made with a glass rod or stick of sealing wax can be made with the lamp.

FIG. 1.

FIG. 2.

If, in the dark, the lamp is held by one hand and the bulb rubbed with a piece of cloth, the interior becomes filled with a bluish white light. (Fig. 2.)

I find that the hand is as good as anything for the above experiment, for if the hand be moved rapidly up and down, striking the bulb a glancing blow as it passes, the glow may be made to fill the entire globe, and, after stopping, if the hand is placed against the glass, the interior will be immediately lighted up, and it may be repeated several times without more rubbing.

When a barrel of lamps is opened and the lamps gently stirred, the same glow spreads through the whole mass of lamps disturbed.

In the above experiments the carbon filament may be entirely destroyed, and for the experiments in attraction and repulsion the lamp would be somewhat improved thereby.

It is, however, as a condenser that the lamp excels.

If the lamp is held by the bulb, and the metal piece connecting with the carbon presented to the prime conductor of an electrical machine, it will become charged, that is, if the person holding it is standing so as to be "grounded."

The lamp can only be charged by an electrophorus, or from a running belt if the latter is charged.

If, when the lamp is charged, the holder touches the metal with his free hand, he will receive a smart shock. If another person touches the metal on the lamp, they both will receive a shock, the circuit being completed through the ground.

If the lamp is held long enough, the time depending on the quantity of electricity to be derived from the charging device, the lamp will finally discharge itself, the spark jumping from the metallic portion of the lamp to the hand of the holder, and the holder is made aware of the fact by the loud snapping sound and a pretty heavy shock. (Fig. 3.)

By watching, the spark may be seen as it jumps the interval.

By taking hold of the lamp well down toward the end of the bulb, the spark can be made to jump the whole distance between the ferrule and the hand, a distance of 3 inches or more.

It is really astonishing what a heavy shock one can get from a 16 candle lamp; and if the original inventors of the Leyden jar had been holding a healthy incandescent lamp in their hands instead of the historic phial of water at the time they received their first shock, it is probable that they would never have ventured near enough to have taken another, judging from the fright the phial caused.

To make a first rate Leyden jar the lamp should have tin foil pasted over it to within $1\frac{1}{2}$ inches or $1\frac{3}{4}$ inches of the ferrule. It may then be held in any convenient way suitable for experiment.

With a lamp so arranged, all the experiments usually made with Leyden jars can be performed.

The foil is, of course, to be connected with the earth. Running a wire to the floor is usually sufficient.

FIG 3.

FIG. 4.

I have taken with the foil on it, suspended it near a running belt, connected the foil to "ground" by running a wire from it to the floor and then run a wire from the metal connection to within a few inches of the belt. So arranged, the lamp will become charged very rapidly and discharge, the spark leaping through the air between the ferrule and tin foil and close to the glass. (Fig. 4.)

During the time of charging the space inclosed by the carbon filament is filled with a pale blue light, and at discharge the whole globe is illuminated, the light being due to discharge in vacua, and not to the carbon being heated.

If the carbon is broken in two, it works just as well, so that burned out lamps may be obtained and used. Anyone who has ever tried to make a Leyden jar knows the difficulty in getting good glass, but the lamp is perfect in that respect.

ON THE INSTALLATION, COST OF WORKING, AND RETURNS OF CENTRAL STATIONS FOR ELECTRIC LIGHTING.

By W. FRITSCHE (of the firm of Fritsche and Pischon, Berlin.)

SINCE the technical difficulties which a few years ago stood in the way of the establishment of large central stations for electric lighting have been obviated by the improvements in the construction of dynamos and of suitable motors, and are in the course of further reduction in consequence of the experience which is constantly accumulating, the questions of working cost and of returns come to the front.

Both separate installations and the few existing central stations prove that the electric light is a necessity.

The prejudices formerly entertained and supported by the strongest evidence are shaken, and there remains now only a single objection, that of uncertainty and expense.

How erroneous are current opinions on the rational working and the expense of the electric light, not only among outsiders but even among engineers, appears from the fact that even specialists still regard the electric light as a luxury.

In our days when restless greed seeks to turn night into day, a "luxurious illumination" is no longer the question. Even the best and clearest light is remunerative. In many manufactories and workshops the possibility of dispensing as far as necessary with daylight is a preliminary condition for success.

To delay in recounting the various advantages of the electric light, including those of a sanitary nature would be superfluous. It will be sufficient to oppose the notion of "luxurious illumination," the groundlessness of which will be shown in the course of this memoir.

The satisfactory circumstance that a great number of municipal authorities turn their attention to central electric lighting proves that the last prejudices against the electric light are fading away.

But the municipalities encounter fresh difficulties which may, in substance, be reduced to the question :—"What is the most rational, the most certain, and the safest method of producing and distributing electric energy ?"

The hesitation in the choice of a system of production and distribution can be overcome only when a wider circle of technologists, including principally the technical officials of the municipalities, and above all, the managers of the corporation gasworks are enabled to form an accurate and independent judgment on the position of the technics of electric lighting.

The author will attempt by an appropriate exposition of all the circumstances to free the question from all obscurity, and to put an end to the concealment favoured in some quarters—a concealment which gives rise to the suspicion that the electric light is not yet ripe for close criticism.

The installation of large central stations can be recommended without fear of depreciation. The materials presented by science have been tested in practice to such an extent that such installations are no longer to be regarded as an experiment, but are to be required, not merely in the interest of the electric light, but in that of the entire machine industry.

In order to establish these assertions we must not merely test the production and distribution of electrical energy as to its theoretical and practical value, but, at the same time, the question of outlay and return must be viewed in intimate connection. The problem must therefore be put as follows :—

How can the certain and economical production and distribution of electric energy be carried out in accordance with our present knowledge, and in how far are such installations remunerative ?

The conversion of mechanical work into electric energy can now be practically carried out on a scale corresponding to that of the conversion of heat into mechanical work.

If the latter conversion by means of the steam engine must, if theoretically regarded, be pronounced imperfect, the limits which are reached in practice have been considerably extended by improvements in boilers and in the construction of modern steam engines.

A similar advance is aimed at in the generation of electric energy, and it has been attained by improvements in the dynamo. Thanks to the efforts of the engineers specially concerned, the working of a central station for the electric light is not more complicated, difficult and uncertain than that of extensive waterworks.

Now the construction of dynamos and motors has been improved, up to the present point the centralisation of electric lighting becomes practicable if the necessary conditions for the distribution of the electric light are fulfilled.

The construction of the Berlin central stations was the first extensive undertaking of the kind in Germany. The incentive was the central station erected by Edison at New York, in which the electric current was directly distributed by a parallel arrangement. As the American conditions are not immediately available for our more complicated demands, very extensive modifications of the Edison system had to be adopted.

For the production and distribution of electric energy there have been various systems evolved in the course of time.

In these various systems the electric energy occurs in two forms, currents of "high" and of "low" tension. In order to fix the relative conceptions of high and low the conventional limits of tension, as occurring in the systems of distribution must be mentioned.

Tensions of 65—200 v. are called low ; those up to 2,000 v. are regarded as high.

Corresponding to these two forms of electric energy, whether in continuous or alternating currents, various systems of distribution have been elaborated.

High tension currents, whether continuous or alternating, are distributed in relatively small conductors, the lamps being placed in series. Such high tension currents are transformed into others of low tension. In the second form of energy there occurs almost exclusively a direct distribution of the low tension currents ; the current is divided into parallel circuits, the ramification being either two-fold, three-fold, or manifold.

In all systems of distribution we have to deal merely with electric energy in proportion as it is produced, since its storage in accumulators has not become of sufficient importance to be taken here into account.

We will endeavour in the first place to solve the above problem on the basis of personal experience for the direct system of two-fold distribution.

We must first examine the factors which determine the rational production of electric energy. This production must take place in such a manner that the electric light is available at pleasure at all hours, up to a certain limit. To meet the hourly and daily fluctuations in the consumption of light it appears desirable to draw electric energy as wanted from a store, just as gas is drawn from a gas-holder. But, as will appear upon further consideration, if the motors and dynamos are suitably chosen and the conductors properly arranged, such a storage is not required. Both as regards the quality of the light and economy the desired object is reached if the production of electric energy keeps pace with the momentary consumption of light. Every storage of energy involves losses, that of electric energy especially so, and it is therefore very expensive. An indirect storage, however, is effected in the steam boiler.

(*To be continued.*)

OKONITE.

THIS is a form of insulation comparatively unknown in this country, but one which is being steadily brought before the electrical world of the United States. However much an insulator may be found on its introduction to possess all that is excellent, there is one point that the test of time alone can supply — that is its durability or lasting qualities, and until some years have elapsed it is quite certain that no new insulation can reasonably expect to have any support extended to it.

Okonite has now been in use in the United States for some four years, and as the practical experience obtained of its durability and insulating qualities has been of a favourable character, we hear of its extended use in connection with insulated conductors for telegraph, telephone and electric light purposes.

"Okonite" is the name given by J. J. C. Smith, of Passaic, New Jersey, to the rubber composition which he uses as an insulating covering to electric conductors manufactured under his system, in order to distinguish it from many other compositions used for the same

purpose. The composition is a scientific product obtained by many years of practical experience in the manufacture of rubber; the process is, however, a secret, but it is stated that okonite contains only 38 per cent. of fine pure caoutchouc, the balance being pure natural hydro-carbon oxides and silicates; it contains no oxidised oils, or other detrimental artificially produced substitutes.

The essential difference in this dielectric is in the mode of manufacture. The composition is not applied as in other manufactures, but in a manner special to itself, which consists in placing the conductor in long strips of the composition which are wrapped round the wire and closed with a longitudinal seam. A plan somewhat similar to this was applied to gutta-percha in its earliest days, but with the present material it is carried out in a very different manner secured by patent. The composition is first rolled out upon sheets of stout tinfoil, by the pressure of the rollers of the machine, the two surfaces are made to adhere firmly. The sheets of composition with the metallic envelope are then cut into regular strips of a width slightly in excess of that required to wrap round the wire with a longitudinal seam. The okonite strips with the metallic covering are then joined end to end, forming a long continuous band which, as it is formed, is wound for convenience and for the operation of covering, on to a reel. The wire to be covered is also wound on to a reel, and a special machine (patented) is employed through which the wire and the tape pass, by means of which the insulator is laid on longitudinally and "seamed." The metallic envelope has the important advantage of protecting the insulation covering during the process of vulcanisation against contact with air, moisture, or steam, and, according to the inventor, producing remarkable results, the insulation being higher than that by any other process, and increased strength, tenacity and durability being obtained with great uniformity in the quality of the product. The covered core previous to vulcanising is wound on to a special large reel or drum to the amount of two or three miles. This reel, when so charged, is then rolled into a vulcanising vessel in a horizontal position. During the process of vulcanisation the reel with its charge is slowly rotated; this rotation has the effect of keeping the metallic conductor perfectly in the centre of the insulation covering, which becomes very soft when heat is applied before the actual vulcanisation takes place. The rotation of the reel and charge continually changes the gravity of the conductor, thereby preventing the dislocation of the conductor from its central position in the insulated covering. This last-named improvement avoids the very serious trouble in the manufacture of vulcanised rubber core, eccentricity of conductor; besides, it saves a great deal of manual labour over the old methods.

After the insulation covering is vulcanised, the metallic tin envelope having served its function, is removed at a trifling expense, and by re-melting and re-rolling into sheets it can be used for the same purpose for a long time.

Okonite-covered wires and cables have been submitted to experts in the United States and careful tests have been made. Professor E. Frankland, in forwarding the results of his experimental examinations, remarks: "These tests have convinced me that the material possesses, in a very high degree, all the qualities which render it valuable for electrical purposes. The resistance to leakage is extremely high, and the cables themselves are not easily injured by rough treatment." Mr. George Hamilton, chief electrician of the Western Union Telegraph Company, gives a large number of tests of okonite core supplied to his company, and remarks: "I would say that having tested 300 miles or more of the okonite core and finding it so uniformly good, I have learned to have a very high appreciation of it." In a subsequent report he says: "The Western Union Company has quite a large amount of the core in service, giving the best satisfaction. The insulation of the core is exceptionally good, and, so far as my experience goes, is not surpassed for aerial or underground work." The fact that a large quantity, amounting to some hundreds of miles, has been used by the Western Union Company, is sufficient proof of the excellence of the material.

As regards the electrical and mechanical properties of "okonite," an exhaustive report by Dr. John Hopkinson, F.R.S., gives some information. The specific inductive capacity of the material is found to be 4·6, slightly higher than the usual value given for gutta percha. The insulation resistance of the several samples was uniformly high, and tests taken at varying temperatures showed that it was affected in a greater degree than ordinary rubber. For instance, the tests of one sample gave

at 60° F. 7,587 megohms per stat. mile.
„ 75° F. 3,810 „ „ „

figures which correspond nearly with the coefficients given in the company's own table for the effects of temperature. Numerous tests were also applied by Dr. John Hopkinson to see if mechanical distortion and distension had any effect on the insulation, but no deterioration ensued. Dr. Hopkinson in his report remarks: "It has, of course, been impossible to ascertain the durability of the insulation when exposed for a long time to the air. The only test which has been made to ascertain whether the contact of foreign substances has any deleterious effect on the insulation is the following:—10 feet from B coil were immersed in colza oil for four days, exposed to the air for one day and then tested; the average rate of loss during five minutes was ·00035 per second, corresponding to insulation resistance of 8,386 megohms per mile, proving that the material had in no way suffered." The tests given by Dr. Hopkinson are remarkably good, but the results obtained by him are best given in his own words: "*Summary.*—Shortly, my tests on these samples of Mr. Smith's insulated conductors prove that the insulation is practically perfect, both for high and low potentials, it is at least equal to the best G. P., and that the insulation will stand very rough handling and a considerable temperature without injury, indeed, with a quite insignificant reduction of the insulation resistance."

In a later communication from Mr. Hamilton of the Western Union Company, he remarks: "My experience with the okonite core, for something over two years, has been very satisfactory. I have yet to learn of the first case of deterioration of the core that has passed under my inspection, although, in amount, it figures up several hundred miles, and is used in both aerial and underground cables."

It is claimed for this core that the "tenacity and toughness of the material renders it non-liable to destruction by reason of abrasion or rubbing of foreign substances." We have ourselves tested samples of this core mechanically in a variety of ways, and also under the application of heat, and find that it fulfils all the conditions guaranteed by the makers. Whilst resilient it is remarkably tenacious, and its strength and toughness are very great; the wires are uniformly well covered, and its durable qualities may be taken, from all the evidence we can obtain, to be very great. It is not attacked by acids, and greasy substances do not affect it. We have only noticed that paraffin oil has a remarkable action upon the material. In the samples we have tested, the copper not being tinned shows the effect of vulcanising, but in a much less degree than in ordinary vulcanised cores.

For ordinary telephone work we think that the inductive capacity and the amount of covering required are rather against the adoption of okonite, but for general telegraph work, especially for "leading-in" at stations, signal boxes, &c., this core will be specially valuable. Its mechanical properties, high insulation, and indifference to heat, render it a very efficient core for electric light purposes, and we should not be surprised to see it used largely for such positions and places where most insulated wires have hitherto proved failures.

NEW ALTERNATING DYNAMOS.

By R. KENNEDY.

(*Continued from page* 597.)

THE author's alternating current dynamo mentioned in the previous notes is illustrated diagrammatically in figs. 1 and 2 showing the arrangement of field magnets. Fig. 1 is a section showing the exciting coil which is embraced by the iron shell of the magnet; there are in this machine six poles of similar polarity on one side of the armature, and six poles of similar polarity on the other side of the armature, all the N poles being on one

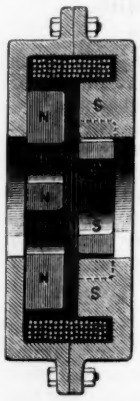

FIG. 1.

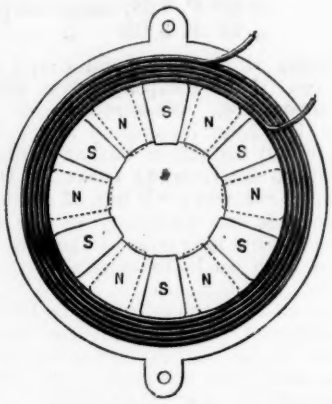

FIG2. .

side and all the S poles on the other. The iron shell is made up of three pieces, a short cylinder of large diameter and two end pieces; these end pieces have six projecting poles radially arranged so that the polar faces approach closely, leaving only a small space for the armature. Fig. 2 shows an inside view of the end piece.

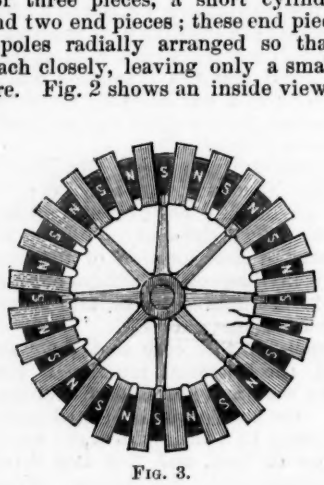

FIG. 3.

When an armature, such as is shown in fig. 3 containing iron in the core is employed, the poles are arranged as shown in the diagram, that is with the poles on one side opposite the space between the poles on the other side. By this device, although all the poles on one side are similar, the magnetic lines of force passing through the coils are reversed alternately. With an armature without iron the poles on opposite sides face each other, and the coils in the armature must be twice the number of magnetic fields.

The same arrangement of poles is also suitable for an armature as shown in fig. 5. This armature has a core formed of thin strips of soft iron wound up to form a disc; the faces of the disc are grooved out to carry the coils which are made of strip copper and wound as the well known Ferranti or Siemens coils. In applying the ironclad field magnets to this armature, the only difficulty is to make the armature rigid enough to withstand the powerful side pull of the poles on the iron core, should it get a little closer to one set of poles than the other. In using such an armature the coils are double the number of magnetic fields, and the poles may either be placed facing each other, or the poles on one side may be opposite the spaces between the poles on the other side of the armature.

It will be observed that this form of magnet has all the features claimed for the Mordey form of field magnets, lately described, the chief difference being one of construction. The Mordey is arranged to revolve while this one is arranged to be stationary, otherwise they are the same in the following particulars:—

1. They are a simple form to make.
2. A single exciting coil suffices for a machine of any size, speed, or number of alternations.
3. They have poles of one sign only on each side of the armature.
4. The magnetic leakage between adjacent poles on each side is absolutely nil.

Three 8-unit dynamos with this form of magnet were made in the summer of 1886; two of them have been at work ever since, and they have been quite satisfactory. Fig. 4 shows the complete machine, from a photo.

FIG. 4.

Complete self regulation of alternating dynamos is almost obtained by constructing the machine with a very powerful field and weak armature, considered magnetically, and hence the importance of improving the field magnets. The E.M.F. depends on three factors—

1. The length of wire in the armature coils;
2. The strength of the field magnets;
3. The speed of the driven part of the machine.

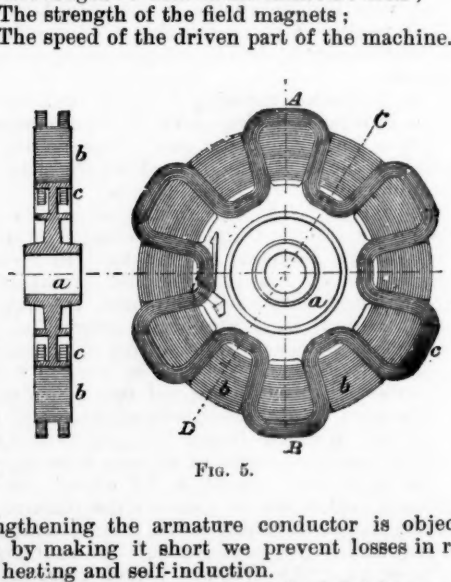

FIG. 5.

Lengthening the armature conductor is objectionable; by making it short we prevent losses in resistance, heating and self-induction.

There is a limit to the speed of driving, so that practically we are driven to the increasing of the strength of the field magnets.

The ironclad form is most powerful, and when applied to armatures with iron cores very short armature conductors are required, and hence the machine gives a characteristic curve showing very nearly a constant E.M.F., constant enough for practical work, without any regulating appliances except a few resistances in the exciting circuit.

The armature shown in fig. 3 is the class used by the author in the ironclad field magnets, and represents one for a machine to give 20 ampères at 2,000 volts; it is built of strap iron wound up to form a disc ring on the periphery of a wheel. Radial slots are cut in the face and the coils wound into the slots; the iron of the armature comes close up to within one-eighth of an inch of the field poles, thereby reducing the air space and giving great increase of power to the magnetic field.

The armature, fig. 5, is one shown in "Dredge's Electric Illumination" as made for the machine designed by Messrs. Muirhead and Hopkinson in 1881. It is built up somewhat similarly to the one represented by fig. 3, and wound zig-zag like the Ferranti. An experiment made with it in the ironclad field magnet gave good results, and, no doubt, it would form an excellent armature for this class of machine.

(*To be continued.*)

THE INSULATION OF MAINS FOR HIGH TENSIONS.

By G. L. ADDENBROOKE.

THE success of central station lighting is now well assured as far as the station itself is concerned. Likewise no particular engineering or electrical difficulties confront us in utilising the current in consumers' houses or public buildings. But between these extremities there is a gulf. The advocates of low tension say, let us bridge it over with copper, masses of copper. The representatives of high tension answer, the weight of copper will crush your undertaking and carry you into the gulf you are trying to bridge. To this the low tension party reply:—Nay; but even so, there is more danger of your being "burst up" than of our being crushed.

So there the matter rests, waiting until the logic of events has decided one way or the other. And by one way or the other I do not mean between high tension or low tension systems, but between the practicability or non-practicability of carrying high tension currents underground. The low tension system with its mass of copper and its resistances and regulating appliances we have with us always, a solid if dull reality, merely depending on the depth of the consumer's purse.

But electrical engineers may well look forward to something cheaper, more elastic and more readily adaptable to the various needs and conditions which they have to meet. A high tension system offers these advantages provided that with the tensions used the current can be confined to the mains. That such a system may succeed we must be able to rely thoroughly on the insulation of the mains and their branches into consumers' houses, and, moreover, the cost of this insulation must not be excessively heavy.

Very encouraging results have already been attained, so that a candid mind knowing what has been done, can hardly doubt that complete success will finally crown the efforts of those labouring in this field. But there have been some failures, or at any rate difficulties have in some instances been encountered, which tend to check growing confidence, and to make people timid and hang back.

Wherever such failures have occurred, however, it would be found, could the causes be gone into properly, that they have happened from too much being attempted with given means, or because the proper conditions of success were not fulfilled, and not because success itself was unattainable.

Success in dynamo construction, and the spread of the electric light which followed it, occurred when the general principle of dynamo construction began to be better understood and utilised, and so complete success in the insulation of mains and the impetus which it will give to electric lighting will be best and most quickly attained by a study of the general principles involved, and then by the application of these principles to practice.

Before going further, it may be well to settle what the word "high tension" is to mean. The term is comparative, and its definition will no doubt vary somewhat with the progress of electrical engineering, so that the lines of demarcation cannot be strictly laid down.

But most "high tension" work, whether for arc lighting or with alternating currents and transformers, is done with potential differences of from 1,000 to 3,000 volts, so that between these rather wide limits the definition must lie.

Conductors may be insulated in two ways; by supporting them on insulators or by surrounding them with a dielectric, or these two methods may be combined. The object in any case is to confine the current to the conductor, and to prevent its completing its circuit in any other way. Supposing it does complete its circuit in some other way, how does such an accident come about? Well, we say there is some fault in the insulation, the current taking advantage of the weak place breaks it down, an earth or short circuit occurs accompanied—except in the case of direct metallic contact—with an arc. All is then over until either the fault is remedied, or until the arc burns sufficient of the surrounding material away to form an insulating space, which it sometimes will do. This series of effects is of course to be distinguished from mere leakage, though inordinate leakage is usually the forerunner of such effects, and as such falls to be considered with them.

In designing successful conductors for high-tension currents, it is this disruptive tendency of the current with which we have primarily to cope. Faults in electric lighting cables occur in unsuspected places, and at unforeseen times, and the effects of the current are nearly always such as in a large measure to destroy the traces of the initial actions which have ultimately led to a breakdown. It is easy, as a rule, to account for everything from the instant an arc is formed; but what is more important to the engineer is what were exactly the steps which led up to the formation of the arc; how did it get itself started?

There are three ways in which an arc can be set up, by bringing two conductors together and then separating them after the current has started flowing, as in the ordinary arc lamp. By placing a piece of conductive material between the two conductors, which becomes heated by the passage of the current, volatilises, and so starts an arc, as in the Jablochkoff candle. Lastly, if two conductors are brought near enough to each other the current will spring across the intervening air space and often start an arc, notwithstanding that the insulation resistance of the air space is practically infinite.

We may leave out of consideration metal coming directly into contact with the conductor as a mechanical accident to be guarded against mechanically. Therefore it is probable that when arcs are formed and breakdowns occur on electric light circuits they are led up to by a fissure or crack in the insulation by some conductive material forming on the surface, by water finding its way in by the current directly leaping across the intervening space, or by a combination of these actions. There may be some further effect with which we are not acquainted, though it seems to me that, making due allowance for the obscurity of the whole phenomena, the effects mentioned are together sufficient to reasonably account for the kind of failures which we generally meet with.

Some years ago Messrs. Warren de la Rue and Muller made a great number of careful experiments with their chloride of silver battery on the distance a spark would leap across air at various tensions. Their conclusions agree within reasonable limits with determinations by Sir William Thomson and others, and as bearing directly on the question, I take the liberty of quoting some of them here.

Using an apparatus by which the opposing surfaces were slowly brought together, they found that at the tensions given in the first column the sparking distances in decimals of an inch were as follows :—

Volts Tension.	Between two spheres.	Between disc and point. Decimals.	Between disc and point. Fractions.
200	·001	...	$\frac{1}{1000}$
500	·002	...	$\frac{1}{500}$
1,000	·005	·005	$\frac{1}{200}$
2,000	·012	·021	$\frac{1}{50}$
4,000	·032	·097	$\frac{1}{10}$
8,000	·078	·335	$\frac{1}{3}$

It will be noticed that whereas at 1,000 volts the sparking distance is much the same between two spheres as between a disc and a point, yet at higher tensions the distance the spark will jump between a disc and point rapidly increases as compared with the distance it will traverse between two spheres.

Other similar experiments showed that the sparking distance was about one-eighth greater between two concentric cylinders than between two spheres. Between two points the sparking distance is still greater than between a disc and a point at high potentials, but does not appear to be different at low or moderate potentials.

These experiments refer to continuous currents. I do not know if any similar set have been tried with alternating currents, though now with transformers it would be easy to do so. Alternating currents do not form arcs so readily as continuous currents or such long ones ; though, on the other hand, there is a general impression that they are more trying to insulation. What actual grounds there may be for this impression I cannot say, although I have frequently endeavoured to do so I have never been able to get at any facts which bear directly on this side of the subject. My impression is that it is simply a generalisation, from the fact that with an alternating current the maximum difference of potential in the circuit is double the mean. Perhaps, also, this has something to do with it, that it is sometimes found effective in breaking down faults, so as to localise them in submarine cables, to apply the current first in one direction and then in the other.

On the other hand, there is, I think, at any rate, one argument against the disruptive tendency of an alternating current being twice as great as that of an equivalent continuous current. Alternating current machines, as generally made, do not work with less than 6,000 alternations per minute, or 12,000 reversals, the alternation beginning at zero, rising to a maximum in one direction, then falling to a maximum in the other direction, and lastly returning to zero. The current therefore increases from zero to a maximum in one direction or the other, 12,000 times a minute, or 200 times per second.

When a continuous current is passed into a cable the cable becomes charged like a condenser. If the current to charge the cable is passed through a reflecting galvanometer, the spot of light first of all will be thrown right off the scale by the rush of current into the cable. It soon begins to come back, but only gradually, and the final permanent deflection due to the leakage through the dielectric is hardly reached under an hour. These effects are all very carefully and fully described, accompanied by a table of the observed fall for gutta-percha, in Kempe's Electrical Testing, under the heading "Measurement of High Resistances." Here are a similar set of figures for some first-class electric light cables made by the India-rubber Company, the tests being taken at their works. The cables were in half-mile lengths. The first reading was not taken until the battery, the E.M.F. of which was nearly 600 volts, had been on the cable for *one minute* :—

	1st min.	2nd min.	3rd min.	4th min.	5th min.
Deflection on scale	260 ...	180 ...	140 ...	120 ...	110
,, ,,	150 ...	105 ...	90 ...	80 ...	75

The second cable was rather more highly insulated, *proportionately*, than the first.

These figures show that the electrification of the dielectric is not quite complete even five minutes after the current has been put on. How much less complete will it be then five *seconds* afterwards, and again $\frac{1}{200}$th of a second afterwards, which is the time of a reversal with the alternating current. It must also be recollected that with alternate currents each succeeding current has not only to charge the dielectric but to discharge the charge left in the dielectric by its predecessor.

It appears to me that a current can hardly exert its full influence, or the strain be full on a dielectric until electrification has attained its maximum. If this supposition is correct, it seems fair to infer that as with a rapidly alternating current electrification cannot attain its maximum, therefore the strain on the dielectric cannot be so great as that which would be due to the full alternating difference of potential if applied continuously.

ON DEATH BY THE ELECTRIC CURRENT.

IN the last issue of THE ELECTRICAL REVIEW was an article by Prof. E. J. Houston entitled as above, being an abstract from "Proceedings American Philosophical Society." Dr. Robert Amory writes in the *Electrical World* that it would hardly be right to allow the explanations of the cause of death by high tension currents as given by Prof. Houston to go unchallenged in the light of physiological knowledge as possessed by medical men of the present day.

According to this knowledge, acquired by experiments on animal life, as well as the observation of pathologists on the appearance of human bodies of those who have been destroyed by lightning and strong electrical currents, medical men are of the opinion that most generally death by electricity is caused by asphyxia rather than by any chemico-physical effects upon the living tissue.

In support of this opinion, the comparison of post-mortem appearances of the body of an animal destroyed by electricity shows a similarity with the appearances of the body of individuals destroyed by drowning or other forms of death by asphyxia.

The animal tissues, after death by lightning or other strong electrical action, do not decompose any sooner than after any other form of sudden death. Moreover, attempts at resuscitation of an individual apparently lifeless, after the passage through the whole body of a strong electrical current, should be resorted to, which are usually effectual in restoring the animal functions of life in those who have been subjected to asphyxia and cease to breathe. These attempts should be made by efforts to restore the respiratory movements, and are often successful even when there is apparently no hope of resuscitation. It will be evident that if a living body is held between two conductors of opposite potentials of electrical condition and receives the full current between a very high electrical potential passing to a very low potential, and cannot be extricated in time, the animal functions of muscular contraction are thrown into a strong tonic spasm, which will prevent the free respiratory movements which are essential to life. If these conditions are maintained for a sufficient period of time, the natural movements of respiration are delayed long enough to suspend the movements

of blood in the capillary circulation. Thus the tissues are paralysed and oxidation of the blood ceases, and in consequence the blood ceases to stimulate the heart to action.

This is a brief description of a more correct explanation of death by strong currents of electricity than any which is dependent upon electrolytical action of the tissues, suggested by Prof. Houston.

EEFECT OF CHLORINE ON THE ELECTRO-MOTIVE FORCE OF A VOLTAIC COUPLE.*

By Dr. G. GORE, F.R.S.

IF the electromotive force of a small voltaic couple of unamalgamated magnesium and platinum in distilled water is balanced through the coil of a moderately sensitive galvanometer of about 100 ohms resistance, by means of that of a small Daniell's cell plus that of a sufficient number of couples of iron and German silver of a suitable thermo-electric pile (see Proceedings Birmingham Philosophical Society, Vol. IV., p. 130), the degree of potential being noted, and sufficiently minute quantities of very dilute chlorine water are then added in succession to the distilled water, the degree of electromotive force of the couple is not affected until a certain definite proportion of chlorine has been added: the potential then suddenly commences to increase, and continues to do so with each further addition within a certain limit. Instead of making the experiment by adding chlorine water, it may be made by gradually diluting a very weak aqueous solution of chlorine.

The minimum proportion of chlorine necessary to cause this sudden change of electromotive force is extremely small; in my experiments it has been one part in 17,000 million parts of water;† or less than $\frac{1}{17000}$th part of that required to yield a barely perceptible opacity in ten times the bulk of a solution of sal ammoniac by means of nitrate of silver. The quantity of liquid required for acting upon the couple is small, and it would be easy to detect the effect of the above proportion or of less than $\frac{1}{100000}$ millionth part of a grain of chlorine in $\frac{1}{10}$th of a cubic centimetre of distilled water by this process. The same kind of action occurs with other electrolytes, but requires larger proportions of dissolved substance.

As the degree of sensitiveness of the method appears extreme, I add the following remarks. The original solution of washed chlorine in distilled water was prepared in a dark place by the usual method from hydrochloric acid and manganic oxide, and was kept in an opaque well-stoppered bottle in the dark. The strength of this liquid was found by means of volumetric analysis with a standard solution of argentic nitrate in the usual manner, the accuracy of the silver solution being proved by means of a known weight of pure chloride of sodium. The chlorine liquid contained 2·3 milligrammes or ·03565 grain of chlorine per cubic centimetre, and was just about three-fourths saturated.

One-tenth of a cubic centimetre of this solution ("No. 1") or ·003565 grain of chlorine was added to 9·9 cc. of distilled water and mixed. One cubic centim of this second liquid ("No. 2") or ·0003565 grain of chlorine was added to 99 cc. of water and mixed; the resulting liquid ("No. 3") contained ·000003565 grain of chlorine per cubic centimetre. To make the solutions ("No. 4") for exciting the voltaic couple, successive portions of $\frac{1}{10}$th or $\frac{1}{20}$th cc. of "No. 3" liquid were added to 900 cubic centimetres of distilled water and mixed.

I have employed the foregoing method for examining the states and degrees of combination of dissolved substances in electrolytes, and am also investigating its various relations.

* Read before the Royal Society, May 3rd, 1888.

† As 1 part of chlorine is 17,612 million parts of water had no visible effect, and 1 in 17,000 millions had a distinct effect, the influence of the difference, or of 1 part in 500,000 millions, has been detected.

REVIEW.

Principles of Dynamo-Electric Machines, and Practical Directions for Designing and Constructing Dynamos. By CARL HERING. New York: W. J. Johnston. 1888.

We have before us a work, the first from America, which treats exclusively of dynamo-electric machines. The book is certainly characteristic of the continent from whence it comes, and its contents we have read with pleasure and studied with interest. It is not intended, says the writer in his preface, for experts, physicists, or theorists, but for dynamo builders, machine tenders, amateurs, and students. Of exact science there is in this book none, but of empirical dicta there are plenty. Its place is evidently in the drawer of the workman's bench rather than on the library shelves of the university.

In his first chapter Mr. Hering deals with electrical units and fundamental data, passing on to the principles of dynamos and motors in his second chapter, and to magnetism and electro-magnetic induction in his third. In this chapter we are given a fair idea of the author's method, and know that right through the volume we may expect a qualitative rather than a quantitative treatment of the subject. When Mr. Hering does become exact the data are derived from constants based on experiment, but these constants are not referred to fundamental laws, as in our practice. On page 28 the author says that the current flowing in the inductor tends in all cases to oppose or weaken the magnet, and gives the practical rule followed in all good machines, namely, to "make the magnetism of the field as strong as possible, and the counter magnetism of the armature as small as possible." The current in the inductor weakens the field if there is a lead given to the brushes, and though this is the condition under which dynamos are uniformly worked the circumstances upon which the weakening depends ought to be clearly stated, this naturally leading to further statements regarding the magnitude of the effects produced.

Mr. Hering, in Chapter IV., considers the generation of electromotive force in dynamos, and devotes Chapter V., which occupies a large proportion of the book, to the subject of armatures. There is much that we take exception to in these chapters, and the treatment is far from scientific in its character. We have chapter after chapter of generalities, enriched, it is true, with all sorts of little practical hints and workshop tricks, but containing no quantitative laws. We have, ourselves, no love for mathematics for their own sake, considering them merely as a means to an end—that end the concise representation of physical truth. Nevertheless, accustomed as we have been to express relations symbolically, and with that precision which the scientific knowledge of our time renders possible, we cannot help thinking that a treatise which leaves the design of dynamos to mere rule of thumb is somewhat behind the age. We do Mr. Hering no injustice in saying this. There are necessarily many things the settlement of which in dynamo construction must be left to the judgment of the designer, for the determination of which he has no data to draw upon, save his experience, and for proportioning which he can formulate no rules. It is in such cases that the designing instinct, if we might so call it, is displayed. It is here that the designer, urged by some irresistible impulse, cuts half-an-inch off this part, or puts half-an-inch on that, because somehow it seems better so to his eye. But, on the other hand, there are well-known established laws to which the design should always be subservient. The man who is thoroughly acquainted with these possesses designing reason as well as designing instinct, and as in the animal kingdom the organism gifted with reason occupies a higher place than the organism possessing mere instinct, so the electrical engineer who possesses both the qualifications we have mentioned occupies in the electrical world a better position than the engineer who constructs instinctively

only. The laws which form a basis for the rational design of dynamos we miss in Mr. Hering's work. He has written for a class of reader which is assumed by him not to be in want of such data. So instead of law is furnished empiricism, and for theory is substituted literally a wealth of practical information.

But let us consider a few of the author's statements. On page 39 Mr. Hering refers to the idle wire inside a Gramme armature, saying that the question of the wire being idle is still under dispute. The majority of electricians in this country would assure him that the wire is as dead as the Spaniards who landed with Columbus, provided there is no leakage of lines of force inside the core, and if there is leakage, that the wire is active and its activity is in the wrong direction, since it opposes the induction in the outside wire. Nevertheless there is another point to consider in dynamo action beside the cutting of lines of force, and we are not aware of any authentic experiment which proves without question that the inside wire is idle. Mr. Hering's rule for the distance between the tips of the polar extensions is to make this at least eight times the distance between the iron of the armature core and the bored surface of the poles. It might be more, but should never be less. We do not quite agree with Mr. Hering as regards the cross section of the armature core. Given a magnet of a certain section and by increasing the iron in the armature the lines of force through the latter for the same excitement can be increased, but we eventually reach a point where the increase is not sufficiently marked to compensate for the heavier armature. Thus in the machines made on our side of the Atlantic we rarely find the armature core containing a section greater than ·75 of the magnets. From this it ranges down to ·5, and a great many machines are made between the two. Mr. Hering thinks the cross section of the armature should be equal to that of the magnets.

In Chapter V. some interesting information is given regarding the inductor velocity of various machines. In the latest Edison machines it ranges from 46 to 54 feet per second, and in the Weston incandescence from 37 to 43 feet per second. In the Weston arc it is 61 feet per second, while in the 60-light Brush it reaches 72 feet. The flat ring Schuckert machines have an inductor velocity of 65 feet per second. Mr. Hering finds that in the Weston incandescence machine the induction is from 1 to 1·3 volts per foot of active wire on the armature, while in the arc machine it is from 2·2 to 3·2 volts. By the active wire the author means that lying between the pole pieces and the iron core, excluding that inside the armature and that lying between the polar tips. In the Edison machines the induction is from 1·5 to 1·8 volts per foot. As the induction depends on the product of velocity and strength of field to reduce to a common basis, these figures must in each case be divided by the velocity in feet per second, when we get for the Weston incandescence machine ·025 to ·030 volt per foot of active wire, and for the Weston arc ·044 to ·052 volt. The Edison machines come out at ·033 to ·037 volt. The diametrical depth of the wire on the Weston machines is from 8 to 10 per cent. of the outside diameter of the armature, while in the Edison machines it is from 8·8 to 11·5 per cent. In this chapter on armatures, the author sums up very concisely the relative advantages of the Siemens and Gramme winding, but dismisses alternating current armatures in two and a half pages. The well-known American alternators are not mentioned, and what little reference there is made to this type of machine is out of date. In concluding this division of his subject Mr. Hering makes the necessary calculations for the yield of continuous current armatures, first assuming that a certain induction can be obtained per foot of wire and determining the length required, next obtaining the size of the wire from these, the diameter of the armature, and lastly, the inductor velocity. He then finds what the intensity of field must be in order that the required voltage may be obtained under the conditions so fixed, and from the answer ascertains whether his iron core is sufficient or whether modification in either of the factors is necessary. It is a trial and error method and consequently very roundabout compared with the methods which electricians with us employ.

The author in Chapter VII. passes on to consider field magnet frames, this portion being pretty much a reprint of his book on field magnets. There is given here a deal of general knowledge on the subject of magnets, but, as far as we can see, no attempt is made at rational calculation from fundamental laws. One sentence we give which justifies this remark. "Scientists have up to the present time," says the author on page 120, "failed to give the dynamo builder any practical and reliable data and rules by means of which the actual sizes of the parts of a field magnet frame may be determined with any degree of certainty from the intensity and size of the field required by the armature." This is certainly a strange utterance for the year 1888. But notwithstanding the fact that the work done by Hopkinson and Kapp is not utilised, the empirical rules given are in their way much better than the vague and incomprehensible mathematical jargon which appears too frequently in many of our own text books. The remarks just made will apply with equal force to the chapter on field magnet coils, and our brief notice must now come to an end. The concluding chapters on compound machines have been published in our columns as well as the principal matter contained in the appendices. On the whole, the book is well worth reading, and a large amount of practical information can be gained from it. It pretends to be a workshop companion more than a scientific treatise, and it is precisely what it pretends to be.

BRADFORD ELECTRIC LIGHTING.

On Thursday morning last week Major Tulloch, R.E., one of the inspectors of the Local Government Board, held an enquiry at the Town Hall, Bradford, in respect to the application of the Corporation for sanction to borrow £20,000 for the purposes of the proposed electric lighting installation in the borough. There were only about half a dozen persons present in addition to the inspector. Alderman Frederick Priestman, chairman of the Gas Committee, and the Town Clerk (Mr. McGowen) represented the Corporation; and Mr. J. N. Shoolbred, electrical engineer to the Corporation, was also present.

The Town Clerk, in laying the case of the Corporation before the inspector, stated that some time since the Corporation obtained a confirmatory Act of Parliament which empowered them to supply electricity for lighting purposes and for motive power. By that Act two years' grace was given to the Corporation, within which time they were to do something towards putting into operation the powers granted, subject to the condition that if the Corporation did not move within that period, and any company wished to take up the project, the powers granted to the Corporation should not stand in the way. Before the two years expired, however, the Corporation introduced a Bill into Parliament containing clauses seeking to make their electric lighting powers permanent. The Board of Trade, after considering that portion of the Bill, came to the conclusion that it would be undesirable to give to the Corporation such powers in a permanent form, but gave them an assurance that if any other persons came to the borough with any project the Corporation should be duly considered, and the powers granted to them should remain in their hands unless there had been unreasonable and wilful default on their part. About that time, as the inspector would be aware, the subject of electric lighting was not so far advanced as it had since become, and it was thought best to let the matter remain in abeyance for awhile, pending such improvements as might be made. Some time afterwards a company came to the Corporation and asked for permission to carry cables over the streets. This seemed to the Corporation a most objectionable mode of procedure, considering the weight of the cables and consequent danger to the public; and as other persons, including the Post Office authorities, were required to carry wires underground in the busy parts of the town, the Corporation refused the application. To some people it might have seemed ungracious on the part of the Corporation to refuse liberty to the company to use their electric powers, while at the same time the Corporation had similar powers but neglected to carry them into effect. The Gas Committee thought it well to bring the subject up for discussion in the Council, and, it being found that there was likely to be a considerable demand for the electric light, it was, after full enquiry and consideration of the subject in all its bearings, determined that the Corporation should make a start. No one, however, yet knew sufficient of electric lighting to justify the setting up of a complete system for the whole borough, and it was thought that the most judicious mode of proceeding would be for the Corporation to select a central portion of the town and to have a limited installation put down until it was seen how far the project was successful. Plans were therefore pre-

pared by Mr. Shoolbred, acting for the Corporation, and it was resolved to seek powers to borrow the necessary money; and the Council having made application to the Local Government Board for that purpose, as directed by the Act of 1883, the result was the enquiry now being held. As the inspector well knew, the Corporation was required to give the utmost publicity to everything they did, and such had been the case in the present instance. So far as could be ascertained, the scheme seemed to meet with very general approval, and the absence of opposition was a strong testimony in favour of this view. It should be stated that the trade of the town was of a peculiar character, and the Corporation was told by the merchants that the electric light would be a great convenience to them, as facilitating the matching of tissues of the various textile fabrics produced in the town, as also in showing off the various shades of colour. It remained for the inspector to say whether he felt justified in recommending that sanction be given for the Corporation to borrow the amount for which application had been made. It was at first thought that £20,000 would be sufficient to meet the demands, but when tenders had been received for the necessary works it was found that nearly the whole of that sum would be absorbed, and the Corporation requested to be allowed to amend their application, so as to include an additional £5,000. In the year 1871 the Corporation bought up the undertaking of an old gas company, and it might perhaps be thought that in seeking now to supply electricity they were cutting their own throats; but being satisfied that there was a demand for the electric light they wished to be able to supply it themselves, and so maintain the exclusive control of the streets, as they were apprehensive that if any trading company were to get a foothold in the town the difficulties of the Corporation would be very much enhanced. It was most desirable that only one authority should deal with the streets, and every arrangement would be made to secure economy in carrying out the project.

Alderman F. PRIESTMAN added his confirmation to the Town Clerk's statement, and explained the desirability of having the works proceeded with as soon as practicable. Considering the substantial character of the plant to be laid down, he urged that the term of the loan should be as long as possible.

The TOWN CLERK proposed to call Mr. Shoolbred, the Corporation's electrical engineer; but the inspector stated that the engineer had already supplied him with the fullest particulars, and that no further information was really needed on his part, adding that there was nothing in relation to the scheme generally, or arising out of the inquiry, to which he saw the least objection. The inspector remarked that the best course for the Corporation to adopt would be to address to the Local Government Board a supplementary application for the additional £5,000 required. It was highly desirable that an enquiry should have been held, as the subject was new both to the Corporation and the Department. Indeed, he believed the Bradford Corporation were the first municipal authority to take action in the manner they proposed.

On the motion of Alderman PRIESTMAN, seconded by Mr. JOSEPH EDMONDSON, a vote of thanks was passed to the inspector for his courtesy in conducting the enquiry, and Major TULLOCH having responded, the proceedings closed.

THE POSSIBILITIES AND LIMITATIONS OF CHEMICAL GENERATORS OF ELECTRICITY.*

By FRANCIS B. CROCKER.

ELECTRO-CHEMISTRY seems less generally and less clearly understood than any other branch of electricity of equal importance. The facts concerning the dynamo, motor, telegraph, and telephone are widely and definitely known; but there are ideas, statements, and claims in regard to batteries which are further from the truth, more prevalent and go longer without being contradicted than any other collection of errors that I can call to mind.

Primary batteries have not received the attention in this country that they have abroad, particularly in England, where the successful or unsuccessful attempt to float a new primary company is a matter of almost weekly occurrence. Nevertheless, the subject is a sufficiently important one, and the false ideas of which I have spoken have spread so far beyond the quacks, to whom such ideas are usually confined, that the subject deserves more study than it usually receives, particularly from the scientific standpoint.

Electromotive Force.—The electromotive force which a given battery or combination of materials will develop is the first and most important question in electro-chemistry. Of course, the best and surest way to arrive at this E.M.F. is to determine it by actual experiment with a voltmeter, or, still better, by comparison with a standard cell. There are, however, many times when the materials or instruments are not at hand, and a calculation or predetermination of the E.M.F. is very convenient.

The formula for calculating the E.M.F. is obtained by assuming that the electrical energy of the given chemical combination is equal to the heat energy which the same combination is capable of producing, or $E C = 4{\cdot}16\ C\ a\ H$. That is, volts multiplied by coulombs is equal to the coulombs multiplied by the electro-chemical equivalent, *i.e.*, the weight of material required per coulomb and that by the heat produced by one gramme of the material. Cancelling the C in both members, we have $E = 4{\cdot}16\ a\ H$, in which E is the E.M.F. in volts, a is the electro-chemical equivalent (grammes per coulomb), and H is the number of heat units (gramme-degrees Cent.) produced per gramme of material by the given chemical combination. The values of a and H are given for most materials in electrical and chemical books of reference, and the calculation is a very simple one. Nevertheless this formula and the principle involved in it are not generally understood and are very seldom used. The equation deduced above is that ordinarily given, but what I have found to be a more convenient form of it is obtained by assuming that $E = H$, giving a its value for hydrogen (·00001035). Solving with respect to H we have $H = 23{,}300$, which means that 23,300 is the number of heat units per equivalent corresponding to one volt, and all that is necessary to find the E.M.F. of any given chemical combination is to divide the number of heat units per equivalent (which is the form they are almost always given in) by 23,300 and the quotient is the E.M.F. in volts. For example, to obtain the E.M.F. which zinc and free chlorine will develop divide 48,600 (which is the number of heat units produced by the combination of one equivalent of zinc with one of chlorine as given by Thomson) by 23,300, and the result 2·09 is certainly very close to 2·11, the actual value obtained by experiment. In the same way the E.M.F. of other combinations of materials may be predetermined, but it should always be borne in mind that the heat of combination corresponding to one *equivalent* of the material should be taken and not necessarily that corresponding to one atom; as for example in the case of zinc, the heat per atom (65 grammes) is 97,200 which has to be divided by 2 to reduce it to one equivalent because zinc is a dyad and takes two atoms of chlorine, which is a monad. In the case of monad metals like sodium, potassium, and silver, the figures may be taken just as they are given in the tables. Mistakes very frequently arise in this way; in fact I do not think I ever saw a table of electro-chemical equivalents in which this point was correctly introduced in every case.

In order to test the practicability and accuracy of calculating E.M.F., as well as to obtain reliable results and full data for their own value, I determined the E.M.F. given by 13 of the most important metals in combination with free chlorine, bromine, and iodine, and the results are given in Tables A, B and C respectively. In Table D, I have averaged these results, and placed them side by side with the results obtained by calculation. The agreement between the two sets of figures is not perfect by any means, but when it is remembered how the E.M.F. of a cell will change one or two-tenths of a volt on apparently the slightest provocation, I think the figures are strikingly close, more so than I expected to find them. In more than half of the cases the difference is less than one-tenth of a volt, and the average difference is only slightly more than that. There has been no warping or coaxing of the figures to secure uniformity. The results are given just as they came. If figures were picked out from the different observations it would be possible to obtain almost perfect agreement between the calculated and determined, as one may see by looking over the tables.

In regard to the experimental results as given in Tables A, B and C, I may state that all the metals and salts used were chemically pure, with the exception of the metals magnesium and aluminium, and these were of a very good quality. Pure carbon plates were used for the negative plate, but platinum was also tried and gave substantially the same results. The E.M.F. was measured by a Thomson reflecting galvanometer (by Elliott) using two independent standard Daniell cells. One fact which strikes one in looking over the Tables A, B and C, is that the E.M.F. is not very greatly affected by the solution; a certain metal gives about the same result in one chloride as in another, and the same is true of the bromides and iodides. In Table E, I have given the E.M.F. obtained by substituting different metals for the zinc in a Daniell's cell, but these results being from only one series of observations are probably not so reliable as those in the preceding tables.

TABLE A.

E.M.F. produced by different Metals in Combinations with Free Chlorine in Solutions of

	Magnesium chloride.	Zinc chloride.	Zinc chloride.	Zinc chloride.	Hydrochloric acid.	Common salt.	Average.
Magnesium	2·83 2·65	2·65	...	...	3·2–3·15	2·85	3·1
Zinc	2	2·20	2·13	2·11	2·20	2·18	2·11
Cadmium...	...	1·94	...	1·86	1·98	1·93	1·9
Aluminium	1·75	2·04	1·88	...	2·02	1·98	2·
Iron	...	1·60	1·56	1·5	1·67	1·68	1·6
Cobalt	...	1·43	1·43	1·41	1·50	1·45	1·43
Nickel	...	1·33	...	1·27	1·40	1·33	1·33
Tin	1·50	1·70	1·6	1·57	1·68	1·66	1·61
Lead	...	1·63	1·62	1·60	1·68	1·65	1·63
Copper	...	1·31	1·30	1·29	1·37	1·34	1·32
Silver	...	1·11	1·12	1·13	1·15	1·10	1·11
Antimony...	...	1·20	1·23	1·25	1·25	1·08	1·22
Bismuth ...	...	1·29	1·25	1·20	1·27	1·19	1·21

In the remaining table I have collected in condensed form the principal facts in regard to batteries in which zinc is used as

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the electro-positive material with the most important electro-negative or depolarising materials. The facts in regard to metallic zinc, which hold good in all cases in which it is used (no matter what the other material is), are given on a horizontal line with zinc. Below this the facts in regard to each particular combination are given opposite the depolariser. For example, the data of a zinc and chlorine battery are given on a horizontal line with chlorine, of a zinc and nitric acid (Bunsen) battery on a line with nitric acid.

TABLE B.

E.M.F. of different Metals with Free Bromine in Solutions of

	Magnes. bromide.	Nickel bromide.	Potass. bromide.	Hydro-bromic acid.	Magnes. bromide weak.	Average.
Magnesium...	2·55	2·45	2·51	2·7	2·57	2·56
Zinc	1·84	1·78	1·82	1·79	1·85	1·79
Cadmium	1·6	1·54	1·62	1·57	1·61	1·58
Aluminium...	1·5	1·46	1·47	1·46	1·6	1·53
Iron	1·22	1·25	1·31	1·26	1·33	1·3
Cobalt.....	1·1	1·02	1·05	1·06	1·13	1·05
Nickel.....	·8	·85–·8	·8	·87	·94	·85
Tin	1·12	1·31	1·3	1·25	1·27	1·3
Lead	1·4	1·27	1·33	1·28	...	1·33
Copper	1·05	·96	1·01	·99	1·03	1·02
Silver	·97	·94	·97	·95	·93	·95
Antimony ...	·99	·73	·71	·87	·97	·8
Bismuth.....	·92	·9	·96	·88	·92	·92

TABLE C.

E.M.F. of different Metals with free Iodine in solutions of

	Magnes. Iodide.	Zinc Iodide.	Potass. Iodide.	Average.
Magnesium	2·02	...	2·00	2·01
Zinc	1·35	1·23	1·29	1·25
Cadmium	1·12	1·12	1·13	1·12
Aluminium	·92	·83	·87	·88
Iron	·69	·6	·74	·68
Cobalt	·6	·42	·5	·51
Nickel	...	·35	·37	·36
Tin	...	·72	·69	·71
Lead	...	·82	·85	·83
Copper	·63	·67	·62	·64
Silver	·65	·67	·64	·65
Antimony	·41	·47	·46	·44
Bismuth	·39	·46	·42	·43

For convenience the table is divided into two parts; the left-hand side contains the purely scientific data, and the right-hand portion contains the practical facts.

In the first column of the first part are given the chemical symbols reduced to a common basis, any one of the expressions being chemically equivalent to any other. For example, one-half atom of zinc ($\frac{1}{2}$ Zn) requires one atom of chlorine (Cl) or one-half atom of oxygen ($\frac{1}{2}$ O), or one-third molecule of chromic acid ($\frac{1}{3}$ Cr_2O_3), or one-sixth of the mixture of one molecule of potassium bichromate and seven molecules of sulphuric acid ($\frac{1}{6}$ [$K_2Cr_2O_7 + 7H_2SO_4$]), and so on.

In the second column is given the chemical equivalents which are simply the proportions by weight required of the different materials. That is, when we use 32·5 grammes (hydrogen being assumed as one gramme), we require 35·5 grammes of chlorine, or 33·4 grammes of chromic acid, and so on.

TABLE D.

Comparison of the E.M.F. Calculated from the Heat of Combination and the E.M.F. determined by experiment.

Metals.	Combining with chlorine calc.	Determ.	Bromine calc.	Determ.	Iodine calc.	Determ.
Magnesium	3·24	3·1	...	...	...	...
Zinc	2·09	2·11	1·68	1·79	1·05	1·25
Cadmium...	2·	1·9	1·58	1·58	·97	1·12
Aluminium	2·3	2·	1·7	1·53	1·00	·88
Iron ...	1·75	1·6	1·5	1·3	·85	·68
Cobalt ...	1·64	1·43	...	...	...	...
Nickel ...	1·57	1·33	...	...	...	...
Tin ...	1·71	1·61	1·5	1·3	...	...
Lead ...	1·76	1·63	1·38	1·33	·85	·83
Copper ...	1·4	1·32	1·07	1·02	·69	·64
Silver ...	1·25	1·11	·97	·95	·59	·65
Antimony...	1·3	1·22	...	...	...	...
Bismuth ...	1·3	1·21	...	...	...	...

TABLE E.

E.M.F. produced by different Metals substituted for the Zinc in a Daniell's cell.

Metals.	Volts.	Metals.	Volts.
Zinc	1·08	Lead	·58
Cadmium	·79	Copper	·07
Aluminium	·65	Silver	·02
Iron	·64	Antimony	·09
Cobalt	·40	Bismuth	·17
Nickel	·1		

The third column contains the electro-chemical equivalents, which are really exactly the same and directly proportional to the combining weights in the previous column, but are reduced to an electric basis of so many milligrammes per coulomb. To convert these figures into grammes per ampère hour simply multiply by 3·6.

In the first column of the second part of the table is given the E.M.F. of each combination, all of which with the exception of oxygen, sulphur and water are determined by experiment, most of them being well known and accepted values. In the case of

SYMBOLS. Chemical expressions reduced to a common basis.	Chemical equivalents. Proportions in which materials combine. H = 1.	Electro-chemical equivalent. Weight of material consumed per amp. sec. milligrams per coulomb.	NAME OF MATERIALS.	Electro-motive force produced. Volts.	Weight of zinc consumed per horse-power hour. Pounds.	Weight of depolariser consumed per horse-power hour. Pounds.	Weight of materials consumed per amp. hour in each cell. Pounds.	Cost of materials wholesale. Per pound.	Total cost of both positive and negative materials per horse-power hour.
$\frac{1}{2}$ Zn	32·5	·337	Metallic zinc	...	...	...	·0027	$·07	...
+			used with following electro-negative or depolarising elements:						
I	127·	1·314	Free iodine	1·2	1·67	6·53	·0105	3·50	$22·97
Br	80·	·828	Free bromine	1·79	1·12	2·76	·0066	·38	1·12
Cl...	35·5	·367	Free chlorine	2·11	·95	1·04	·0029	...	...
$\frac{1}{2}$ O	8·	·083	Free oxygen*	1·9	1·05	·26	·00066	...	...
$\frac{1}{2}$ S	16·	·166	Free sulphur*	·95	2·1	1·03	·0013	·02	·17
			CHEMICAL COMPOUNDS.						
$\frac{1}{2}$ H_2O	9·	·093	Water*	·5	4·	1·1	·00074	...	...
H NO_3	63·	·652	Nitric acid	1·9	1·05	2·04	·0052	·06	·20
$\frac{1}{3}$ CrO_3	33·4	·346	Chromic acid	2·	1·	1·03	·0027	·20	·28
$\frac{1}{2}$ Cu SO_4 ...	79·7	·826	Copper sulphate (anhyd.)	1·079	1·86	4·55	·0065	...	...
$\frac{1}{2}$ Cu SO_4 ·5 H_2O	124·7	1·29	Copper sulphate crystals	1·079	1·86	7·13	·0102	·06	·56
$\frac{1}{2}$ Fe_2Cl_6... ...	162·5	1·683	Iron perchloride ...	1·55	1·3	6·5	·0133	·10	·74
Ag Cl	143·5	1·487	Silver chloride	1·06	1·89	8·32	·0118	16·00	133·25
$\frac{1}{2}$ Hg_2SO_4 ...	248·	2·57	Mercury sulphate ...	1·42	1·41	10·7	·0204	·50	5·45
			MIXTURES.					Mixture per lb.	
$\frac{1}{8}$ { $K_2Cr_2O_7$ / 7 H_2SO_4 }	163·5	1·694	{ Potass, bichrom, 3 parts / Sulphuric acid, 7 parts }	2·	1·	5·03	·0133	·04	·27
$\frac{1}{5}$ { $K_2Cr_2O_7$ / 4 H_2SO_4 }	229·	2·37	{ Potass, bichrom, 3 parts / Sulphuric acid, 4 parts }	2·	1·	7·04	·0186	·05	·42

* Calculated.

oxygen, sulphur and water the E.M.F. is calculated as explained above and is merely given for comparison. No actual battery corresponding to these materials exists.

In the second column, on the right-hand side, is given the number of pounds of zinc required per horse-power hour in the case of each combination. For example, a zinc and copper sulphate (Daniell) battery requires 1·86 pounds of zinc per horse-power hour of electrical energy produced.

In the next column I give the weight of depolariser required per horse-power hour in the case of each combination. For example, a battery requires 5·05 pounds of the mixture of three parts of potassium bichromate, and seven parts of sulphuric acid, which is about the ordinary strong bichromate solution for porous cell batteries. Of course the water required for the solution is not considered here or in any of the other figures of the tables, because it costs nothing and serves merely as a medium of electrical action; but if the total weight of solution is desired, the weight of water must be added.

The weight of the different materials consumed per ampère hour is given in the next column. These figures are obtained directly from the electro-chemical equivalents in the third column by dividing by 125; in fact, they are simply the electro-chemical equivalents in pounds per ampère hour.

It should always be carefully noted that the weight consumed per ampère hour is that required in *each cell* in *series*, whereas in the case of horse-power hours the weight given in the table is the total weight used, no matter how many cells there are or how they are arranged.

In the next to the last column is given the wholesale cost per pound of the different materials. These prices are of course very difficult to fix, because they depend upon the market and vary greatly upon the quantities bought; but the prices I have here are very low and ordinary consumers would have to pay twice as much in most cases; they give, however, some idea of costs.

In the last column I have given the cost of both materials, zinc and depolariser, added together. I have not here considered the values of the products, because it is very difficult to estimate the cost of collecting and utilising residues. In the case of silver chloride the silver resulting from the action would, of course, be worth a large portion of the cost of the original chloride.

One of the interesting points which this table shows is the total weight required per horse-power hour. For example, ·95 pound of zinc and 1·04 pounds of chlorine, making a total of almost exactly two pounds, would produce one horse-power of current for one hour if all of the chemical energy could be converted into electric energy.

This brings up the question of how large a percentage of the chemical energy can be utilised, or, in other words, the efficiency of chemical generators. This efficiency is higher, I think, than it is generally supposed to be. I have no exact figures upon this point, but I have tested several times the weight of zinc consumed compared with the theoretical amount, and I have found that even in a plunge battery, where the bichromate solution was directly in contact with the zinc and the opportunity for local action was a maximum, that the zinc efficiency was as high as 75 per cent., and in one case 80 per cent. In a porous cell battery with amalgamated zinc, where there was little or no cause for local action, I believe the zinc efficiency would be as high as 90 per cent., and I should not be surprised to find it as high as 96 or 97 per cent.

The efficiency of the depolariser is generally lower than that of the zinc, because there is generally a good deal of chemical energy left in the solution after it is too weak for satisfactory work. The efficiency of the bichromate solution in the plunge battery I have just referred to was only about 45 per cent. of the total theoretical power. But this is very low, because the solution has to be weak in acid on account of being used in contact with the zinc. In the case of a copper sulphate battery, where the crystals of sulphate are often almost entirely used up, I think the efficiency would be as high as 80 or 90 per cent.

The efficiency I speak of here is simply the *chemical* efficiency in the battery; the fall of potential in the battery due to its internal resistance compared to the external is another loss which has to be added to the chemical loss in determining the total efficiency. The possibilities of chemical generators are therefore almost infinite, since it requires theoretically a total of only two pounds of zinc and chlorine, and two pounds of zinc and chromic acid per horse-power hour, and since the efficiency of batteries can easily be made as high as 75 per cent., it follows that less than three pounds of material is actually required per horse-power hour; but unfortunately the water for the solution, the containing vessel, electrodes, &c., are so heavy that the total weight is very many times greater. The possible and the actual battery are thus very far apart. If we use metals of higher chemical affinity and E.M.F. than zinc, the theoretical weight of material required is even less; only one pound total of chlorine and magnesium are required per horse-power hour, with metallic sodium and free chlorine having a calculated E.M.F. of 4 volts, it would only take about ·8 pound per horse-power.

The easiest and best solution of the problem, however, does not seem to be the use of more powerful metals than zinc. The latter is powerful enough; it only takes, as we have seen, about one pound of it per horse-power hour with nitric acid, chromic acid or bichromate solution, and less than two pounds with copper sulphate. The opportunity for improvement seems to lie more in the direction of perfecting the general form of batteries. The *apparatus* is at fault, not the *chemical action*. Moreover, zinc is about as high on the electro-positive scale as it is safe to go so long as water is present. Even in the case of zinc, its affinity for oxygen is greater than that of hydrogen; it is therefore only by tolerance, so to speak, that zinc remains passive in the presence of water. If it is not properly amalgamated, or if the solution is too strong, local action does occur. If, in place of zinc, we use any more electro-positive metal, these troubles are aggravated; with magnesium, for example, there are only very few solutions in which it will stand without great local action. Metals of still higher power, such as sodium, cannot be used at all in the presence of water. Jablochkoff has, I believe, made cells in which sodium is used with damp cloth, but this can hardly be considered as water.

The proper way to use metals of great chemical energy would seem to be with liquids which do not contain any oxygen, but unfortunately such solutions are not generally good conductors. Another possible plan is to employ a fused electrolyte, but this involves the serious difficulty of maintaining it in the fused state.

So far as I can see zinc is a very satisfactory positive material for batteries. After all it is cheaper than any other metal except iron. It is a sufficiently good conductor and less dirty and liable to corrosion than almost any other metal; it is also, as I have just shown, about as high on the electro-positive list as it is safe to go.

The electro-negative materials, on the other hand, leave far more to be desired. They are generally expensive, very troublesome to handle, and introduce that quality of simple dirtiness, to which no other name can be applied, and which is really the most serious objection to batteries. The electro-negatives will, however, do the work, and as we have seen it actually requires very little weight to give a great deal of power, if the materials could only be used in a more perfect manner than at present. That seems to be the thing to hope for. Another serious difficulty with batteries is their high internal resistance. A dynamo can easily be made to give 100 volts with a thousandth or a few ten thousandths of an ohm internal resistance, hence their great output; but a battery capable of giving 100 volts with only one thousandth of an ohm internal resistance would probably fill this house.

In this connection it will be interesting to consider how many cells of ordinary gravity battery are required to give one horse-power of current. Each cell will give one volt and not more than half an ampère under normal conditions, hence each cell furnishes half a watt or about 1,500 cells to the horse-power! These cells would, however, give that power for a long time. But the fact remains that that very large number is required to produce the power which a dynamo not much larger than one's hat will generate.

In conclusion, I would say that I am by no means a sceptic in regard to chemical generators of electricity; the possibilities are very, very great, as I have shown. But these possibilities do not seem to have been brought to reality in a very perfect manner as yet. But batteries, even in the imperfect state in which they exist to-day, have their useful and legitimate function. A Leclanché cell is exceedingly well adapted to ringing electric bells intermittently and to telephone work, and gravity batteries have long done good service for telegraphic purposes.

But when it comes to developing any considerable amount of actual power, then the limitations become apparent. When we remember that battery electricity will certainly cost in practice 50 cents per horse-power hour, since the materials alone cost 25 cents, and that dynamo electricity only costs 2 cents per horse-power hour, the claims of some primary battery electric lighting promoters show up in their true light. As a luxury, of course, it makes very little difference what it costs, but even then people soon tire of paying very high prices for that kind of a luxury. For small electric lighting and small power in special cases batteries are useful, particularly where no other source of current is available. A physician or dentist to whom a horse-power hour may be worth hundreds of dollars could almost afford to use a chloride of silver battery and throw away the silver.

NOTES.

The Lighting of the Prudential Offices.—The Prudential Assurance Co. has instructed Messrs. Drake and Gorham to make a considerable extension to its electric lighting plant. A third Marshall engine, capable of developing 120 horse-power, is to be fixed, and a fourth boiler. In addition to the above, extra dynamos are to be supplied and 264 of Messrs. Drake & Gorham's largest size of batteries. When completed, this installation, with its 2,300 lights of 16 C.P., will probably be the largest plant in the world used for the lighting of a single company's offices.

Conductors for the Burg Theatre.—The underground system in connection with the lighting of the Burg Theatre, Vienna, is at last completed. It has been officially inspected by the President of the Vienna Society of Electricians, who has stated that the only defective insulation in the system existed in the slate supports of the cut-outs, and of the other apparatus of this kind.

Proposed Electric Lighting in Edinburgh.—The Anglo-American Brush Electric Light Corporation has applied to the Edinburgh Town Council for permission to undertake operations for the lighting of Princes' Street houses. On the part of that company Mr. W. Geipel, the superintendent for the district, has supplied a sub-committee with a large amount of information on the subject. The streets committee on Tuesday recommended that permisson should be granted to the Corporation to lay conductors during the pleasure of the Council, and on payment of ninepence per lineal yard per annum. After some discussion the matter was re-committed. Several of the hotel keepers and others are said to have approached the Corporation since the installation of the electric light in the Conservative Club with the view of obtaining a similar supply. It is expected that sufficient support will be obtained to warrant an installation of about 2,000 incandescent lamps. The conductors are proposed to be laid in tubes under Rose Street and other thoroughfares. The Callender-Webber system of underground electric conduits, which has been fully described in the REVIEW, will be adopted. The current will be distributed to the consumers from the central station, and will be charged for either by rental or meter-rate. The Corporation also hopes to be able to supply power to hotels and clubs for lifts and other purposes, as well as to printing and other establishments where it is required, especially intermittently.

Electric Lighting in Milan.—The Milan Società Generale di Elettricità had its annual meeting on the 2nd April, and its report says that, at 31st December, 1887, it had 11,010 glow lamps and 218 arc lamps, as against 9,540 and 154 the year before. A dividend of 8s. per share on the 12,000 shares, or £4,800 in all is to be paid. This is a dividend of 4 per cent. on the £10 shares. Last year it was 2·8, and the year before 1·6 per cent.

Ship Electric Lighting.—A very elaborate system of electric lighting has been adopted by Messrs. John Rennie & Son on their new steamer *Inanda*. The vessel is to be lighted entirely with the single wire system, the lamps being arranged in four circuits, and there are in all about 80 lamps. A feature of the arrangement is the employment of "cargo" lamps, which are conveniently placed so as to facilitate the loading and discharging of cargo during the night. Driving power is supplied by a small slow motion engine fixed in the engine room, and occupying a space of about 6 feet by 3 feet. These arrangements have been carried out by Messrs. J. H. Holmes & Co., electrical engineers, Newcastle-on-Tyne, whose representative, Mr. Henry Stewart, has personally superintended the work.

The steamer *Saikio Maru*, the most recent addition to the fleet of the Nippon Yusen Kaisha, has just been tried on the Clyde. The *Saikio Maru* is specially constructed for mail and passenger service, and when she leaves the Clyde in the course of a week or so she will proceed to Japan to take up her station between Yokohama and Shanghai. Her dimensions are 325 ft. long and 40 ft. 6 in. wide, while the depth is 21 ft. 6 in. moulded to the main deck. The steamer is lighted by electricity. The specification for the installation was referred to Professor Jamieson, and was put in entirely by the Edison-Swan Company. It consists of a Tangye compound engine, driving an Edison-Hopkinson dynamo at 55 volts and 270 ampères, which, reckoning three-quarters of an ampère for every 16 candle-power light, would be sufficient for 360 lamps at a maximum. There are actually in the ship about 30 lamps of 50 C.P. each, and 270 of 16-candles.

On Monday week there was launched from Messrs. Palmer & Co.'s shipbuilding yard, Jarrow, a steamer named the *Seamew*, for the General Steam Navigation Company, and intended for their trade between Granton and London. Accommodation of the most improved character is to be provided for a large number of passengers, and the ship is to be lighted throughout by electricity.

The Bank of England Lighting.—It is satisfactory to learn that the Directorate of the Bank of England are so far satisfied with the result of the extensions of the electric light installation designed by Messrs. Drake and Gorham, that they have given instructions to proceed at once with the lighting of the new branch bank at the Law Courts by means of about 180 lights. It has been decided to put down a 9 H.P. Otto gas engine to drive a 12 unit Elwell-Parker dynamo and a battery of 53 cells made to Drake & Gorham's specification.

Electric Light in Chicago.—At the central post office, Chicago, about 2,500 incandescence lamps are in use day and night. The breakage of lamps, which amounted at first to 30 per day, has been reduced to 5⅓ in the twenty-four hours.

Proposed Electric Lighting at Rothsay. — This favourite Clyde watering place is agitated about its gas supply. A number of influential inhabitants are anxious to introduce the electric light, as they believe it would be economical and a further attraction.

The Electric Light in Bristol Cathedral.—The experiment of the electric light at the Bristol Cathedral has proved so successful that a proposal has been made to use it permanently. It is suggested that the Bristol Corporation or a private company, after witnessing the marked success at the Cathedral, might introduce the system, when there would be little difficulty in the Dean and Chapter adopting it in lieu of gas.

Striking Electric Light Stokers.—The *Daily News* of Wednesday contained the following :—"A bridge is no stronger than its weakest part, and our system of electric lighting, it seems, depends for its efficacy in the last resort on the good temper of our stokers. On Sunday night last many houses at the West End, trusting for light to the London Electric Supply Association, were suddenly plunged in darkness. The secretary of the Association writes to assure us that the defect was due not to anything wrong in the mechanical arrangements, but simply to a strike of the stokers in the employ of the Association. If the light suddenly went out it was only because the stokers had suddenly gone out before it. The alleged reason for this step is even more distressing than the failure of the supply. The men, it is said, were aggrieved because a gratuitous meal of roast beef was served to them cold, instead of hot. We should like to hear the men's story. To say nothing of the injustice to the public, it is hard to believe that they would quarrel with their bread-and-butter on the question of the temperature of their roast beef." Hereafter it will be obviously necessary for electrical contractors to take into account a new quantity when making their calculations, that of roast beef, and the unit of temperature must be regarded as an important factor. Seriously, that such confusion, and possibly danger, should be created by the reckless, selfish conduct of that model personage, the British workman, is scandalous, and, if the facts are as represented, it is to be hoped that some salutary reward will be administered.

Queenstown and the Electric Light.—Tenders are required for lighting the public streets of Queenstown by electricity; also separate tenders for private lighting, for the Queenstown Town Commissioners. Tenders to be lodged with Mr. Jas. Ahern, clerk, Town Hall, Queenstown, up to July 2nd.

Gas Lighting Abandoned.—The local authorities of Erith and the neighbouring district have decided to abandon gas lighting for the next three years, it having been resolved to give a contract for oil lamps during that period. We do not know whether electric lighting could obtain a footing here, but at all events a trial would be worth seeking.

The Telephone Market.—The monthly circular of a firm of stockbrokers which devotes special attention to telephones says :—Telephones have been a quiet market, and prices close flat. The negotiations for the amalgamation of the various interests hang fire. The radical vice which has characterised all the operations of the United Telephone Company since its formation—namely, endless procrastination and discussion in place of action—is no doubt the cause. The shareholders of this company having received good dividends seem quite content to remain ignorant of, or to ignore, the shortcomings of their directors. But for the happy accident that subsidiary companies were formed whereby the management in certain districts was transferred to abler hands, the United Company's dividends would have been small. The company, in fact, is to-day successful, not owing to the exertions of its management, but really in spite of the fact that its best interests have been neglected, and its most important field of operations left practically unworked.

Telephone Call Offices. — One way in which the National Telephone Company displays great activity in securing the extension of its system is in the circulation of literature and information generally concerning the advantages of connection with the telephone exchange. The establishment of call offices has opened up a new field of utility for the telephone, and we have before us the "guide" to the call offices in the Dundee district, in which, besides the pages devoted to information of a positive kind, are many other pages which partake of the nature of argument and general advocacy of the use of call offices. The company, of which Mr. Jas. D. Miller, A.S.T.E. & E., is the district manager in Dundee, does its best to make itself not merely useful, but indispensable.

The Telephone in Kent.—Great progress is now being made with the extension of the telephone in Kent. Two wires are being laid from Canterbury to Dover, in order to avoid any delay in communications. Already half the distance has been covered, and within a fortnight or three weeks the two towns ought to be united. From Canterbury the wire runs to a centre, which is at Wingham. From here it branches off to Dover by the mains round, while on the other hand a line will be run from this centre to Sandwich and Deal, negotiations having been opened this week in those towns. The wires from Ramsgate and Margate are being pushed forward, and will be connected with the system through Sandwich and Wingham.

Sad Death of a Telegraphist. — Mr. F. W. Smith, chief of the telegraph department at the Wolverhampton post office, was found drowned in a canal on Friday last week. He had been for some time suffering from depression of spirits.

Telegraphic Communication between Paris and Rome.—The multiple transmission, commenced at the end of last year, between Paris and Rome has continued to work with the greatest regularity and has given complete satisfaction. We learn that the Hughes instruments have been replaced by the Baudot apparatus as the former necessitated two translations, one at Turin and another at Lyons, whereas the Baudot instruments require only one translation at Turin. This system allows two clerks to each receive or transmit 163 words per minute, the distance being a little under 1,000 miles.

The Telegraphs and the Paving.—On Tuesday at the St. Luke's vestry meeting complaint was made by several members residing in the Goswell Road of the bad condition of the paving after the telegraph *employés* had been attending to their wires. They took up the stones and laid them again, but with only a little mortar at the edges, the result of which was that the stones were soon loose and sometimes dangerous.

A Government Telegram.—Mr. Henniker Heaton asked the Under Secretary of State for the Colonies on Tuesday what was the cost of the telegraphic message sent from the Colonial Office to the Governor of Adelaide, dated December 3rd, 1886, on the subject of New Guinea. Baron H. De Worms: I presume that the hon. member in speaking of the "Governor of Adelaide" means the Governor of South Australia. No telegram was sent to the Governor of South Australia on the date mentioned by the hon. member. One was sent to the Governor of Queensland, at Brisbane, and its cost was £86 5s. 9d.

New Irish-Scotch Cable.—A new cable is about to be laid between Scotland and Ireland. The cable will be laid by H.M.S. *Monarch* from Whitehead, on the county Antrim side of Belfast Lough, to Portpatrick. After the *Monarch* has completed her task she will proceed to the Shetland Isles.

Projected Cable.—The *Globe* of Tuesday evening says :—A London correspondent is informed that the Crown agents for the Colonies have decided to enter into a contract for the laying of a telegraph cable from a point on the coast of Western Australia to India or Ceylon, so as to be in connection with the Indian telegraph system. The sole right to work the cable will be conceded for 21 years.

Cable to the Azores.—We hear from Lisbon that the concessionaires of the submarine cable between Portugal and the Azores have entered into arrangements with an English company for the manufacture and laying of this cable.

The Direct United States Cable.—It is reported that telegraphic communication on this cable is now entirely interrupted. Presumably the *Scotia*, in her endeavour to pick the cable up, or in grappling operations, has broken the cable.

The Schanschieff Battery.—In the last issue of the *Electrical Engineer* we noted the following :—"The Schanschieff Battery Company, Limited, have had an injunction brought against them on the ground of prior invention, and have had to suspend practical operations until further settlement." We are authorised to state that this is quite incorrect, the question of patent rights not having reached such an extreme point as stated by our contemporary. Operations are suspended, but from quite another reason, which we hope will soon be amicably adjusted, for the invention is too valuable to be left slumbering for any length of time.

Electrical Quackery.—We learn that a scheme is being set on foot for the purpose of thoroughly exposing the shams connected with the sale of so-called electro-medical appliances.

Galvanic Belts and Electrical Quackery.—The following is a copy of the latest letter sent to Mr. Jerritt under date of June 2nd :—

Sir,—In answer to yours of yesterday, I have, as requested, again read your libellous letter in the *Western Morning News* of the 17th ult., and although you did not, for obvious reasons, *dare to mention my name or the Medical Battery Company* in connection with the "Self Restorer," you maliciously associated with it my registered trade mark "Electropathic" with the intention of discrediting my patented appliances and *well-known treatment*.

I am advised this constitutes legal damage, and must again ask you to send me an apology, the alternative being an action at law for the Courts to decide. Awaiting reply.—Yours faithfully,

C. B HARNESS, *Managing Director*.

Mr. J. Jerritt.

[Mr. Harness evidently thinks that this bombast will frighten Mr. Jerritt into offering an abject apology, but in this he is, we think, very much mistaken. The advice given to the "eminent medical electrician" that the use of the word "electropathic" is confined to himself emanates probably from some person with an equal amount of intelligence. The assurance of this man is really admirable, and it seems a pity that such determination as he undoubtedly possesses is not employed in a more worthy cause.—EDS. ELEC. REV.]

A New Danger from Electric Lighting.—An extraordinary robbery is just reported to have occurred in the West End. A man is said to have visited 73, Portland Place, and, representing that he was from the Grosvenor Gallery, requested to be allowed to look at the electric light apparatus with which the establishment is provided. His request was granted. The man had a bag with him; this is now supposed to have contained his burgling apparatus. Be that as it may, he is said to have managed to remain in the house until an opportune moment presented itself, when he forced open a number of drawers, and escaped with jewellery and valuables worth at least £2,000. We have on many occasions read of robberies being committed by thieves visiting private dwelling houses in the guise of gasmen who requested to be allowed to look at the meter; by so-called watermen who had been sent by "the company" to examine taps or supply pipes; by telephone inspectors who wished to adjust the transmitter and then appointed themselves receivers general of everything they could lay their hands on; and by other enterprising individuals who could a tale unfold which seemed plausible enough to the innocent victims who are so readily led into such traps. But this affair shows that a new, and, until now, unforeseen danger is connected with electric lighting, and it would be well for the suppliers of electric energy to at once caution their customers in order that they may be placed on their guard against such unwelcome intruders. It was only last week that we were discussing the inconveniences of *bona fide* electric light inspectors entering private houses, and this will be an additional argument to support the views of those who are inclined to oppose the casual visits of electric light companies' officials as being unnecessary and intolerable.

Union Electrical Power and Light Company, Limited.—Mr. H. Evans Broad (Broads, Paterson & Co., chartered accountants) has been appointed by Mr. Justice Chitty official liquidator of this company.

The Brighton Electric Railway.—Councillor Blaker has given notice to move, at the next meeting of the Brighton Town Council, "That, in order to make way for the proposed work and improvements on the Madeira Road, the Town Clerk be instructed to take the necessary steps to have the electric tramway removed from the beach on or before July 1st next."

The Royal Society.—The annual ladies' *conversazione* of the Royal Society was held on Wednesday in the society's rooms at Burlington House. During the evening, demonstrations, by means of Messrs. Drake and Gorham's new electric lantern, were given by Professor Ray Lankester, Mr. W. Gardiner and Mr. J. Norman Lockyer. Mr. Jas. Wimshurst exhibited one of his influence machines, capable of giving a spark 13½ inches in length. Robertson's writing telegraph was also shown by Mr. John M. Richards, and the transmission of six messages at a time by Mr. W. H. Preece. Professor Ayrton also exhibited and explained the various uses of the magnifying spring, including its adaptability to the purpose of a portable voltmeter for measuring alternating potential differences.

Lord Thurlow's Electric Lighting Bill.—The Electric Lighting Act (1882) Amendment Bill has received a curious check to its previously smooth progress. Having passed the House of Lords with but slight modification, the measure went down to the Commons and was read a second time without difficulty. But when the Committee stage was reached Sir George Campbell, who, partly because as a householder in Kensington he has been annoyed by overhead wires, and partly on general grounds, has always taken an active interest in the subject, proposed to add a proviso to the first clause. That clause provides that, "Notwithstanding anything in the Electric Lighting Act, 1882, no provisional order authorising the supply of electricity by any undertakers within the district of any local authority shall be granted by the Board of Trade, except with the consent of such local authority, unless the Board of Trade in any case in which the consent of such local authority is refused are of opinion that having regard to all the circumstances of the case such consent ought to be dispensed with, and in such case they shall make a special report, stating the grounds upon which they have dispensed with such consent." To this Sir George Campbell moved to add "When a local authority duly applies for a licence for an area within its jurisdiction such licence shall be granted by the Board of Trade, unless the Board of Trade are of opinion that special reasons exist why such licence should not be granted, and in such case they shall make a special report stating the grounds of their refusal. The grant of a licence to any company or person shall not in any way hinder or restrict the granting of a licence to the local authority or to any other company or person with the consent of the local authority within the same area." On this proposition being made, Sir M. Hicks-Beach, on behalf of the Government, who have throughout favoured the Bill, announced that he could not assent to it. The first part he described as unnecessary, while the latter part would defeat the object of the Bill. From the other side of the House Mr. Mundella also opposed the amendment, and the discussion was suddenly stopped by progress being reported on the motion of Mr. Biggar, whose interest in the question is not obvious. No opportunity of resuming the discussion has been practicable this week, but the Committee on the Bill is set down for Monday next. It is, however, by no means certain that it will be taken even then.

New Catalogues.—Messrs. Faraday and Son have sent us a copy of their new catalogue of electric light fittings. More than half the designs are quite new, and as a rule are both more electrical in construction and artistic in outline than were the productions of earlier days. Messrs. Watt, Winnall & Co., have also just issued an illustrated price list of electrical sundries and apparatus.

The Copper Ring. — The Paris correspondent of *Money* writes as follows upon the latest development of the copper question:—"A very clever dodge has been matured from the brain of some few very able men, and it is necessary to warn all bears of copper mining shares in good time. It has been decided to create a new concern, with a very large capital, for the management of the metal markets of the whole world. The instigators of the copper deal in October last are, of course, at the bottom of this new idea, and as these gentlemen with their friends are possessed of more than half of all copper shares existing, the programme of the new concern will be, first, to consolidate all mines upon a basis which makes them dependent on the new bank, by having directors, managers, &c., of their own making, which will leave the principal management in the hands of their superiors, to whom they owe their appointments. By so acting it is expected that the control of the entire production will come into one hand, and thus equipped, they will consider every consumer at their mercy. Of course, these gentlemen will make out how valuable such an arrangement will finally prove to all copper companies, and to prove this to the world they will raise the prices of all copper shares without exception. I think it only right to give a warning to all your readers in good time." The views of the City editor of the *Standard* upon this business may be gathered from the following extract from his yesterday's article:—"The attempt to shunt the liabilities of the Société des Métaux, the Comptoir d'Escompte, and other members of the ring on to a new company, specially constructed for the purpose, is looked upon as proof that the load is growing too heavy. We hope not yet. If this kind of robbery by combination is to be done away with, the smash when it does come should be ruinous and complete."

Legal.—In the Sheffield County Court last week an action was brought by Charles Edward Hall, engineer, of Sheffield, against the Telegraph Manufacturing Company, of Helsby, near Warrington, to recover £38 5s. 6d., the value of goods supplied. The case was one relating to a carbon crushing machine supplied to the defendants, and which they subsequently rejected on the ground of its unsuitability for the particular work specified. His Honour now gave judgment for the plaintiff, with costs, but said there still remained a question of warranty between the parties.

Obituary.—The death is announced of Mr. George M. Phelps, sen., a well-known inventor who has been identified with electrical interests for over 30 years. Mr. Phelps, who was the father of Mr. George M. Phelps, editor of the New York *Electrical Engineer*, died in Brooklyn at the age of 69.

The death is announced of Mr. Burchell, of the Sanctuary, Westminster, who was associated with the late Mr. J. L. Ricardo in the promotion of the Electric Telegraph Company.

It is with great regret we have to announce the death at Belfast on June 3rd of Capt. R. Draper, who has commanded the Post Office cable steamer *Monarch* since her first commission in 1883. During the five years Capt. Draper held this appointment he fulfilled his duties ably, and in a quiet unostentatious manner, and appreciated as he was for his qualities as a sailor, he was in a no less degree esteemed by a wide circle of friends for his kindly disposition, and his unfailing readiness to serve those with whom he was thrown in contact. Capt. Draper joined the Silvertown Company in 1879 as second officer and was successively appointed chief officer and captain. He left this company's service in 1883 to take command of the *Monarch*. We understand the cause of death to have been congestion of the lungs, the result of a severe cold caught while engaged in cable repairs during the late severe winter. He was taken ill on board the *Monarch* on the Friday, and on the Sunday morning he died.

Personal.—The honour of a Companionship of the Bath has been conferred upon Capt. William de Wiveslie Abney, R.E.

The position of superintendent of the telegraph department at Aberdeen Post Office, vacant by the death of Mr. James M'Cormack, has been conferred upon Mr. John C. Taylor, one of the assistants.

Prof. Alexander Graham Bell is on his way to England. He has been invited to appear before the Royal Commission now engaged in making an inquiry into the best methods of caring for and educating deaf mutes.

Mr. Frank Ritchell, of New York, the authorised agent of the Sawyer-Man Electric Company, is at present in London making arrangements for the introduction of the Sawyer-Man system of electric lighting.

We have much pleasure in announcing that the directors of the Manchester Edison-Swan Company, Limited, have unanimously invited and elected Mr. I. R. Williamson, A.M.I.C.E., manager of the company, to a seat at the board. Mr. Williamson was at once appointed managing director of the company.

Price of Copper Wire.—We learn from Messrs. Fredk. Smith & Co., of Halifax, that the price for high conductivity copper wire has been reduced ½d. per lb., making the present basis price 0 to 20 10½d. per lb.

Copper Statistics.—According to Messrs. Merton and Co.'s copper statistics, the deliveries in France and England had slightly increased, being 6,044 tons, compared with 5,877 tons in April and 4,489 tons in March. In the month of May, 1887, the deliveries were as much as 10,065 tons.

Ansonia Electric Street Railway.—The first successful electric street railway line in New England has been in operation at Ansonia, Conn., since the first week in May. The line runs up a grade of five feet in a hundred. On level places a speed of 12 miles an hour was made with only one-third of the available current, and since that time the road has been open for business in passenger traffic only. The system is the Van Depoele, and an overhead wire is employed, strung in the centre of the track. Each car is provided with incandescent lamps. The line will be used for freight as well as for passenger service. The cost of construction was $75,000.

The Institution of Civil Engineers.—The Council of this Society has made the following, amongst other awards to the authors of some of the papers read and discussed at the ordinary meetings during the past session. A Watt medal and a Telford Premium to Peter William Willans, for "Economy Trials of a Non-condensing Steam Engine, Simple, Compound, and Triple," and a Telford medal, and a Telford Premium to Edward Hopkinson, M.A., D.Sc., for "Electrical Tramways: the Bessbrook and Newry Tramway."

Forthcoming Publications.—Messrs. Macmillan and Co. will shortly publish a work on "The Theory and Practice of Absolute Measurements in Electricity and Magnetism," by A. Gray, M.A., Professor of Physics in University College of North Wales. Though nominally a second edition of the small book by the same author published in 1884, it has been entirely re-written and extended in plan, so as to form a fairly complete treatise on the absolute measurement of electric and magnetic quantities.

The Management of Accumulators.—We have received a copy of the fourth edition, enlarged and revised, of Sir David Salomons' valuable little work on the "Management of accumulators and private electric light installations." We shall hope to find an early opportunity of commenting upon its technical contents, but we will here again express the wish that some kind friend would revise Sir David's English.

The Earth Connection of Lightning Rods.—Mr. J. E. Smith writes to the *Manufacturer and Builder*:—"A year or so ago a scientific paper, in describing how lightning rods should be connected with the earth, made the statement that all coal was a conductor of electricity. This brought to mind several unsuccessful attempts made by the writer, more than 25 years ago, to get a current of electricity through anthracite coal. After reading the above statement, 8 or 10 specimens each of charcoal and bituminous coal were tested with a 16-cell Smee battery and a sensitive 500-ohm galvanometer. About half of the charcoal was a fair conductor, but most of the other half was practically devoid of conductivity. Out of 8 or 10 pieces of bituminous coal there was one fair conductor, the rest non-conductors. Then several specimens each of anthracite and English and American cannel were tested with a Thomson reflecting galvanometer and 200 cells of gravity battery connected in series. Not one of these specimens showed the slightest indication of conductivity. Coke, especially the greyish coloured, such as is made in coking ovens, is an excellent conductor, and can always be relied on; but neither anthracite nor bituminous coal should ever be used for electrical connections."

The American Edison Incandescent Lamp Patents.—It is announced that Mr. Arthur Shippey has been retained as an expert witness by the Westinghouse Electric Company in the legal proceedings pending in the U.S.A. It is, of course, a foregone conclusion that with Mr. Shippey on the side of Westinghouse, Edison stands no chance. What a thing it is to become famous!

The ss. Kangaroo.—The Telegraph Construction and Maintenance Company's ss. *Kangaroo* arrived in the Victoria Docks on the morning of June 5th, having completed her engagement with the Italian Government for condensing water at Massowah for the troops.

NEW COMPANIES REGISTERED.

"The Electrician" Printing and Publishing Company, Limited.—Capital £10,000, in £10 shares. Objects: To acquire the *Electrician* newspaper and the printing and publishing business carried on in connection therewith at 1, Salisbury Court, Fleet Street. Signatories (with 1 share each):—Sir James Anderson, 62, Queen's Gate; J. Denison Pender, 51, Hans Place, W.; L. Schott and L. Floersheim, 4, Bank Buildings, E.C.; K. L. M. Anderson, 10, Throgmorton Avenue, E.C.; Sir John Pender, 18, Arlington Street, S.W.; James Pender, Thornley Hall, Northampton. The subscribers are to nominate the first directors. Qualification: £300 of share capital; the company in general meeting will appoint remuneration. Registered 31st ult. by Bircham & Co., 50, Old Broad Street.

D'Humy Cabinet Battery Syndicate, Limited.—Capital £15,000, in £250 shares. Objects: To purchase and work the invention patented by P. R. de F. d'Humy for domestic electric lighting, called "The d'Humy Cabinet Battery." Signatories (with 1 share each): James Davidson, 8, The Avenue, Upper Norwood; W. W. Prole, Croyde, Devon; J. Johnstone, 14, Manor Place, Paddington Green; F. d'Humy, C.E., 2, Carlton Mansions, Clapham Rise; J. T. Browne, C.E., 32, Rue Baudin, Paris; W. B. Hertslet, Belle Vue House, Richmond; F. B. Lidstone, 58, Warwick Road, South Kensington. Registered 4th inst., without articles of association, by Hasties and Crawford, 65, Lincoln's Inn Fields.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Automatic Electric Railway Signal Company, Limited.—An agreement dated 12th March, and filed on 25th May, provides for the purchase by the company of the Indian patent rights, and foreign and colonial patent rights of Messrs. Walter Walker and G. W. Sharp in respect of an invention for an improved method of electric signalling for railways and apparatus therefor. The purchase consideration is £19,875, of which £19,750 is payable in fully paid shares.

Schanschieff Electric Battery Syndicate, Limited.—At an extraordinary general meeting of this syndicate, held at the offices, 65, Basinghall Street, on the 23rd of April, it was resolved to wind up voluntarily, and Messrs. Sigmond Hoffnung and Fred. Harvey Harvey Samuel were appointed liquidators, at a remuneration of 50 guineas each, together with a sum equal to one-eighth per cent. each, upon the money received by the liquidators in respect of the sale of patents other than those for the United Kingdom. This special resolution was confirmed at a meeting held on the 9th ult., and was duly filed on the 31st ult.

Nightingale Automatic Electrical Machine Company, Limited.—The statutory return of this company made up to the 4th April, was filed on the 18th April. The nominal capital is £5,000 in 1 A share and 4,999 B shares of £1 each. The shares allotted are 1 A and 1,204 B. Upon 804 shares the full amount has been called up, and upon 400 the sum of 5s. per share has been called. The calls paid amount to £825 and unpaid to £79. The A share is considered as fully paid. Registered Office, St. Stephen's Chambers, Telegraph Street.

Platinum Plating Company, Limited.—At an extraordinary general meeting of this company, held at 27, Clement's Lane, on the 13th February, it was resolved that the capital be increased to £75,000 by the creation of 15,000 cumulative preference shares. The modifications of the purchase agreement, dated 12th December, 1887, which are embodied in the supplemental agreement dated February 2nd, 1888, were also approved and confirmed. These resolutions were confirmed on the 29th February, and were duly filed on the 16th March.

Phonopore Syndicate, Limited.—The first return of this syndicate made up to the 11th May, was filed on the 12th May. The nominal capital is £90,000 divided into 60,000 ordinary and 30,000 deferred shares of £1 each; the latter are allotted and are considered as fully paid. 50,025 of the ordinary shares have also been allotted, 39,025 being considered as fully paid. Upon the remaining shares the full amount has been called; the calls paid being £8,331 5s., and unpaid £2,668 15s. Registered office 27, Clement's Lane.

An agreement, dated 29th March, provides for the allotment to Arthur Rust, of Leicester, and Charles Langdon Davies, of 110, Cannon Street, of 29,025 fully paid ordinary shares and 6,000 fully paid deferred shares as part of the consideration for patent rights acquired under the provisions of an agreement of 14th December. The company will also issue to Zeape and Co., of 27, Clement's Lane, 10,000 fully paid ordinary shares in consideration of great labour, expense and trouble incurred by that firm in the formation and registration of the company.

Sunbeam Lamp Company, Limited (Incandescent Electrical).—The statutory return of this company, made up to the 30th March, was filed on the 3rd April. The nominal capital is £25,000 in £10 shares. 2,204 shares have been taken up, 2,000 being considered fully paid. Upon the remaining shares the full amount has been called, the calls paid being £1,475 and unpaid £565. Registered office, Park House, Gateshead.

Shippey Brothers, Limited (Electrical Engineers).—The statutory return of this company, made up to the 14th ult., was filed on the 16th ult. The nominal capital is £30,000 in £5 shares. 307 shares have been taken up, 300 being considered as fully paid. Upon the remaining 7 shares no call has been made. Registered office, 13 and 14, King Street, Cheapside.

An agreement of the 12th March (filed on the 19th) provides for the purchase by the company of the interest of Mrs. Ann Youles in certain patents of Arthur Shippey, W. J. Laurence Hamilton and Deodato Zanni for £3,000, payable £500 in cash and the residue in fully paid shares.

An agreement of 12th March (filed on the 19th March) provides for the purchase by the company from Mrs. Ann Phœbe Lovering (the sole executrix of the estate of the late Mr. John Folland Lovering) her share interest and right in certain patents of Deodato Zanni, Arthur Shippey and Jules Edouard Wyder. The purchase consideration is £2,000, payable £1,000 in cash and the residue in fully paid shares.

Armstrong Electric Light and Power Company, Limited.—The registered office of this company is now situate at 145, Bermondsey Street, S.E.

CITY NOTES, REPORTS, MEETINGS, &c.

Swan United Electric Light Company, Limited.

AN extraordinary general meeting of this company was held at the Cannon Street Hotel, on Tuesday, under the presidency of Mr. J. Staats Forbes, for the purpose of considering an agreement proposed to be entered into with the Compagnie Continentale Edison, of Paris.

Major Flood Page, the secretary, having read the notice convening the meeting,

The Chairman said: This is a very important meeting for the

shareholders of this company. What we are about to do, in effect, is to imitate abroad what we have done, we believe with great advantage, at home. You know the history of the United Company, in which you have a very large interest. You were in litigation with the Edison Company as to the respective patents of Mr. Swan and Mr. Edison in Great Britain and Ireland. We took very strong views as to the priority and value of the Swan patents; the Edison Company took strong views as to the priority and value of the Edison patents, and we were fast drifting to what might possibly have been ruin to both companies, litigation to the death to settle which was the governing patent and whether there was any patent at all. In that state of things, happily for us, prudent councils prevailed, and the two companies were to come together on the theory of making the best of what had been done, assuming *bona fides* on both sides, which would have the advantage of preventing litigation and avoiding very delicate questions as to the priority and value of both sets of patents, and uniting them both against the common enemy, the infringer. That is what we did in England. It was rather more easy here, for the reason that the Edison Company had the entire control of the Edison patents in Great Britain and the Swan Company had the entire control of the Swan patents. There were no other interests but those two. Abroad it is a little different. There, as here, Swan and Edison are face to face; as here, the one accuses the other of infringement. The Swan Company abroad is in the same position as here: wherever the patents are registered they are the sole possessors of them. That is not the case with the Edison patents. Those patents seem to have been handed over originally to one or more parties, and we find that the Edison Company of Paris, with which we are dealing, has not the same absolute power over the patents for the whole of Europe that the Edison Company in England has for Great Britain. That has led to rather more difficulty in the negotiations. We, the Swan Company, for the last two years have been not indisposed, in view of the uncertainties and cost of legal proceedings on patents to come to an agreement with the Edison Company abroad. But we were face to face with their internal difficulties, and scarcely knew with whom we were to negotiate, or how one district with one set of people was to be protected from another district with another set. We have never swerved in our conviction that what was wise to do here was wise abroad. Whilst conflicts were going on great cost was involved, and there was great uncertainty as to the result. Then the effect of threatening by notice, and the effect of the litigation, acted badly upon the work of installation. People did not like to run risks in which they might be preparing themselves for the defence of an infringement suit. Well, now, the object is to put these two companies together for purposes of mutual protection, for, as in other places, in Europe there are plenty of clever people who like to make lamps upon the patent either of Mr. Swan or Mr. Edison and pocket the proceeds. There is no doubt that we should be much stronger abroad, as we are here, by having control of both sets of patents. Well, if the principle is sound—and I trust you will approve of it and say it is—then comes the delicate point in all such negotiations, the relative values. It is very difficult, I have found, to appreciate the relative value of the partially unknown, because, of course, these businesses, although we have heard of the Swan and Edison lamps for a great many years, are still in their infancy; they are undeveloped businesses, and would have depended very much upon who won the suits. Of course, if the result of the litigation was to debar the Swan Company from manufacturing lamps all over Europe and give the Edison Company, so to speak, the monopoly of that manufacture, the relative proportions of value would be greatly altered. The relative proportions have never been brought to issue, and we have had to resort to the only known factor which influences men's minds in the circumstances, and that is, having both gone on on the theory that the patents were valid patents, we have each done a business, and we are each a going concern. The businesses have been founded upon different principles. We, for instance, have paid cash for our patents; the other people have not paid cash, but have bound themselves to pay royalties upon their patents. We have spent a great deal of money in these foreign countries in bringing our business to its present standard of expansion, money which, as far any result that has at present arisen shows, would not have been justified. But it is like that in other businesses. We have got a going concern now which will increase, and so have they. Well, then, the simple factor was: you have been formed so long, we have been formed so long; how much work have we done, how many lamps have we manufactured and sold? That seemed to be the one reasonable factor; but it had to be modified by some considerations. For instance, if these suits which are pending in two or three countries, in Germany, France, Austria and Belgium, should go absolutely against one or the other, that would be a very disturbing factor, and short of fighting them out to the bitter end one the value of which it was impossible to determine. We thought we had better not challenge it, because if the result of the litigation would be to throw the manufacture open to the world it would be bad for both of us. We have taken very strong views on both sides on the relative value. Fortunately, the method of computing the proportions does not involve the necessity of dealing with the capital of either company or of going into the question of what it has cost A or B. We have taken the factor of the business actually done as the basis of the future division of the profits of the business. What we say in principle is this: put the two things together, get rid of this litigation, proceed as a united company to extend the business, the administration costs will probably be somewhat diminished, the efficiency will be greatly improved, the public mind will be set at rest, there will be no lurking forebodings on the part of people who buy lamps and put up installations that they will be proceeded against as infringers—all that will go, the business will increase, and with the increase in the numbers manufactured and sold the profits on each lamp will increase, for this is one of those cases where a small output shows a profit which is inconsiderable when compared with the profit on a large output. The fact is the establishment charges are so great. If upon an output of a quarter of a million lamps you make a profit of 1s. per lamp, you will probably, if you increase the output to half a million, get a profit of 1s. 6d. per lamp. We think the plan of putting the companies together will effect the double object of increasing the output and of reducing the cost of producing each individual lamp. With this view it is necessary to enter into an agreement with the Continental Company of Paris, and I had better perhaps, before submitting the agreement to you, briefly go through the different articles, so that you may understand exactly what it is. It is to be a union of the two companies. It is to be called the Company General of Incandescent Lamps. The duration of the company is to be fixed, under the statutes, to December 31st, 1894, that being in fact about the period, or a little beyond the period, when the patents of both Edison and Swan lapse. But that term may be prolonged or reduced if the necessity arises, by the resolution of a special general meeting to be called for the purpose, but only when such resolution is passed by a majority of three-fourths of the shares forming the capital of the company. I cannot myself see any reason to believe that, during the term of the patents at all events, there will be any necessity to interfere with this as a going concern. I think it is exceedingly likely that if the business is managed with tolerable prudence in the six years we have to deal with it will involve such a state of things as will leave us in the position, at the end of that term, of a well-established going concern, not protected by patents, which will then be thrown open to the world, but probably protected by improved processes which in the interval may be patented, at all events if not that, by a large connection all over Europe, and by a trade mark which I hope will have behind it the character of the most efficient and best incandescent lamp which can then be produced. I must tell you that this is to be a French company; that is to say, under the French law; the seat of the company will be in Paris, but it may be transferred to any other place. Well now, what do the parties bring in. A going concern; or rather two going concerns. What the Continental Edison Company will bring in will be the rights for France, Belgium, Austria and Hungary, Russia, and Spain. We bring in France, Belgium, Russia, Austria and Hungary, Italy, Sweden and Norway, and Portugal. There is one important area left out, and that is Germany. These gentlemen in Paris have not the power of controlling the Edison interests in Germany, as I had occasion to tell you at some of our meetings. In Germany, among other places, we are in litigation with Edison; but it is not impossible that when this step has been taken, if you see fit to approve of this agreement, Germany may follow. But Germany is excluded from this agreement. As they cannot bring in Germany, we want to be left free there. Everything is brought in in the character of an unencumbered estate. Whatever liability rests upon the backs of the French company will continue on their backs; whatever obligations or claims we have on our shoulders we must carry them. You know what they are so far as we are concerned—the debts for the moment, whatever they may be. There is one important part of the agreement I should like to make clear. I said these businesses have been started on different principles. Whereas we bought out and out the Swan patents by shares and money, the Edison foreign people submitted themselves to a royalty of 20 centimes a lamp, and that has been a great bone of contention and difficulty. It is a payment made to Mr. Edison for bringing in his brains and patents. In our concern I fancy he got money, and also some deferred shares—very little money, and a good many deferred shares. He was clever apparently in France. There he did not get money, but a royalty of 20 centimes, somewhat under 2d., for each lamp made within the area of his patents. We have had to look at that, and we have seen fit—I don't know that I need enter too largely upon a discussion of why we have seen fit, but we have seen fit, as a matter of prudence, and after careful deliberation—to accept that 20 centimes as a charge upon the whole business, but only for the duration of the patents. That is one of the points which made us insist so strongly upon each party bearing its own burden; for according to the language of the agreement between Mr. Edison and his friends and this company, it is not clear that this 20 centimes does not run on as long as that agreement is in existence. Therefore we have limited the duration of the company to the term of the patents in order not to raise that question now. There will be a great many opportunities of considering it in the six years; now is certainly not the time to raise it. We thought it necessary to protect you, when all the world is open to make lamps, from being encumbered with this charge of 20 centimes per lamp which our partners may be encumbered with, but which we do not see any reason to take on our shoulders when others are free. When the liquidation of the business is undertaken each party will return to its rights. I have told you what everybody brings in, and the consideration for bringing it in is the creation of a certain quantity of shares representing what has been done so far—what I may call the cost of the affair up to date—and a further amount of shares representing the capital which it will be necessary to find to develop this business from time to time. Now, it is not a big thing; you need not be alarmed by supposing you have immediately to find more capital. The share capital of the company is to be 2,000,000

francs, which is £80,000, of which 1,000,000 francs is to represent in fully-paid shares, the value of the going concern as put into the common pot, and the other 1,000,000 francs is to be made up of cash contributed by the companies in the respective proportions in which the profits of the united concern are to be divided. The division of these profits was a very anxious matter, and I think you may give us credit for having been ourselves largely interested—not that I think the mere pocket influence is the only consideration which ought to bind honourable men acting in the interests of others; but still it has a certain interest. But being first of all large shareholders, and, what is more, being the implicitly-trusted directors of this company, we made the hardest possible fight about the proportion, and I think Mr. Leyland, who has taken an immense deal of pains over this matter, will agree with me that we have reason to be very well satisfied with the proportions brought out. We think, looking at the relative work done by the two companies; looking at the risks of litigation in these different countries; looking at the position which these people have got into in France, Belgium, and Austria by combinations which they have made with important people—that they stood upon the very nature of the thing to do a bigger business than we did; that is to say, that their chances, if we had gone on even in a friendly way, were of a character to give them a better business than ours. Then there was the great risk of our failing on these patents, and that was a very serious matter; so that altogether the directors are quite satisfied, and are prepared to take all the responsibility of recommending you to accept the proportions. I have told you what the respective proportions of the company are to be in consideration for their contributions. There shall be allotted to the Continental Company 1,200 shares, and to the Swan Company 800, of 500 francs each, fully paid up. That represents the million of francs which I told you would be represented in shares of the going concern. The other 2,000 shares are to be subscribed, 1,000,000 francs in cash in the same proportion as the above contributions, and we shall have to find £16,000 and these gentlemen will have to find the balance—£24,000—and the profits realised in the future will, of course, follow the shares. Of every £100 profit made they get 60 per cent. and we get 40 per cent.; and we think, looking at the matter all round, it is a very satisfactory bargain, and the more one looks at it the more satisfied he becomes. By uniting these companies on these conditions we get rid of the litigation, and shall be able to build up a trade-mark and a business of great value by the time of the expiration of the patents. We think we have done very well indeed, looking at the outlay of the two companies, in arranging for that amount of the net profit, because, after all, the number of shares represents the concrete value, which works out at 60 per cent. and 40 per cent. respectively. Under the arrangement the two companies are put together as a going concern in these countries, and there is an end of all litigation—each party withdraws from the litigation and pays its own costs. One very important matter is this: Suppose in the interval there should arise some unforeseen—as far as the present goes—necessity for terminating this bargain, which could be done in general meeting, recommended by the directors, each company would return to the *status quo ante bellum*, or, perhaps I should say, *ante pace*, with all its rights intact, but not with its right to litigate. Therefore, if at the end of two or three years, for any reason which I cannot imagine we should decide not to go on together, but to separate and each do the best we could, that would not be attended with litigation. Neither party can challenge the rights of the other in the future, and that seems to be a matter of some value, looking at the cost of this litigation. Then, there is the capital. We get 1,000,000 francs as representing what we put in in fully paid up shares, and I may say in the presence of a couple of distinguished lawyers, one English and the other French, that the recent decision does not affect the rights of any company to do what we are doing—it represents so many thousands paid down to carry on the business. These are the general terms of the agreement, but there are some exceptional things I ought to call attention to. The only charge resting on the business, over and above the cost to the parties, is that 20 centimes, and we, for reasons which are satisfactory to our minds, thought it better to accept that for the term of the patents. But there are some other conditions. We were pretty free all over Europe. We had not committed ourselves very much; they had. They had made bargains with a very important firm well known in this country—Sir William Siemens and Co., who are equally powerful people in Germany and elsewhere abroad. They were large manufacturers or installers of electricity abroad, and they had made contracts with the Edison Company under which, in Austria-Hungary and Russia, they are entitled to manufacture lamps, as licensees, upon the terms of certain royalties to the parent company. We have had to face these different arrangements, and there is no getting rid of the bargain with Siemens; but what we have stipulated is that all benefits arising under that shall come into the common pot. Siemens pay 37½ centimes for the right to manufacture the lamps, and they manufacture on a considerable scale, though not so large as to interfere with the scope of our company. They may like to take our lamps at the trade price, or make lamps themselves and pay the royalty, and the parent company undertake to hand these royalties over. They have similar arrangements with an Italian company and with a large firm in Belgium, and whatever the profits are they will come into our pot; they are not entitled to make any charge, and we have the power of control to the extent of examining their books. We have reserved for our company the right to manufacture lamps in Germany and sell them as long as the law will allow us, and if anybody chooses to buy lamps in Hamburg or any of the German ports for export, not to Great Britain, but to any parts of the world where there are no patent laws, we shall be free to do that business. This is the general character of the bargain, though, of course, there are a great many details. The French company have other businesses besides lamp-making, such as the manufacture of dynamos, but we shall not enter into these. The fusion, of course, involves articles of association and the appointment of the directors. Therefore it becomes a matter of confidence. We are very well satisfied with the outcrop of the discussion. Of course, we go in as the minor factor, and we were careful to consider how that minor factor was to be protected from being overridden and outvoted by the major factor. What we did was to get three directors out of a board of seven. That still leaves the governing power in the hands of our French friends; but we could not reasonably claim more. The directors would be nominated for the whole term of the agreement, and it is for the shareholders to say whether they will run the risk of so nominating their directors. The French company have nominated Messieurs. Bernard, Chatard, Rau, and Forgés, while your interests will be represented, if you approve of this agreement, by Mr. Leyland, Mr. Simon—our agent in Paris since the formation of the company, and who is a man of exceptional intelligence and straightforwardness—and myself. Article 12 decrees what is to be done with the net proceeds, after deducting the working expenses. There is to be a reserve fund of 5 per cent., which is according to the common law of France; 6 per cent. interest on the shares; then from the balance shall be set apart 10 per cent. for the board of directors, to be distributed amongst the members in equal parts. Thus, if the shareholders do not get 6 per cent., the directors will get nothing. I beg now to move: "That the agreement now submitted, dated May 5th, 1888, and made between the Swan United Electric Light Company, Limited, of the one part, and the Compagnie Continentale Edison de Paris of the other part, be and the same is hereby approved, and that the directors be empowered to do all acts necessary for carrying such agreement into effect and constituting the new company, and to enter into a further agreement to be made with such new company." The Chairman explained that the further agreement referred to a bargain that the Edison and Swan Company of Great Britain should not make lamps for exportation to any of the countries included in the former agreement.

Mr. F. R. Leyland seconded the motion, remarking that he was convinced that the best arrangement that was possible had been made.

Mr. Bernstingl complained that the shareholders had had no opportunity of considering the terms of the agreement, and asked what the profits were that they had so far derived from the French business.

The Chairman said that unfortunately, owing to the litigation which had been going on for several years, the profits of both companies had been infinitesimal in France, as elsewhere. By amalgamation they hoped to put an end to that condition of affairs. It was not an advisable course to pursue to make the terms of the proposed agreement public until it had been adopted; but in order to enable the shareholders to learn, if they desired to do so, what the terms were, a long notice of the meeting had been given, and if application had been made to the company the information would have been given.

The resolution was carried unanimously, and the meeting terminated with the usual vote of thanks to the chairman.

The Consolidated Telephone Construction and Maintenance Company, Limited.

THE seventh annual general meeting of the company was held yesterday (Thursday) at the City Terminus Hotel, Cannon Street, under the presidency of Mr. C. L. W. Fitzgerald.

In their report the directors state that the accounts for the year ending March 31st, 1888, show a net profit of £10,788 7s. 4d., which, with the amount carried forward from last year, leaves a balance of £12,484 5s. 9d. for disposal, after making provision for doubtful debts. The directors propose to deal with this amount as follows, viz.:—To pay a further dividend of £2 17s. per cent., making with the interim dividend paid in November last, £5 7s. per cent. for the year, writing off the sum of £541 6s. 3d. for depreciation of plant, machinery, and furniture, and the sum of £2,000 from the Edison Gower-Bell Telephone Company's securities, thus leaving a balance of £1,372 9s. 11d. to carry forward. The directors have received a further sum of £4,427 14s. 5d. on account of profit arising from the liquidation of the River Plate business, which is included in the above statement, and there is still a further considerable amount to be received under that head. They have received an interim dividend at the rate of 5 per cent. on the shares of the United River Plate Telephone Company, which is also included in the foregoing. The action brought against the company by Col. G. E. Gouraud for the payment of his fees for the year 1883-84, at the rate of £1,000 a year, was decided in his favour. He has now, after waiting four years, thought fit to commence an action for libel against the committee of investigation, appointed by the shareholders in May, 1884, on the ground that the reports are personal libels. Col. Gouraud's action against the directors for the course they have pursued in conjunction with the Edison Gower-Bell Telephone Company in prosecuting infringers of their patents in Belgium has been again postponed at his request. So far as the action in Belgium is con-

cerned, all has gone favourably, and the case has arrived at the stage when experts will be called to decide if an infringement has been committed. The negotiations in Portugal alluded to in the last report have been satisfactorily terminated, and the result is that a very favourable concession for the working of the telephone business in the cities of Lisbon and Oporto has been granted to the Anglo-Portuguese Telephone Company, to whom the Edison Gower-Bell Telephone Company sold the Portuguese exchange business for 37,500 fully paid £1 shares in the new undertaking. The directors have deemed it necessary to terminate the contract which they had for the manufacture of telephones, &c., and to take the management of the factory entirely in their own hands. This was accomplished in February last, since which time all has been working smoothly and satisfactorily. Under the agreement with the contractor your company had to purchase a certain amount of material and stores which explains the increase of stock, shown in the accounts. The directors have pleasure in stating that they are working in complete accord with the United Telephone Company, from whom they are expecting large orders, seeing that the development of that company is progressing very favourably. A fusion of all the telephone companies of the United Kingdom being in contemplation, their directors are using their best endeavours to promote the shareholders' interests in connection with the same.

The business of the subsidiary companies continues to make most satisfactory progress as is shown by the following statement:—

	Year ending March 31st.					
	Subscribers.		Rental.		Increase.	
	1887.	1888.	1887.	1888.	Subscribers.	Rental.
			£	£		£
Telephone Company of Austria	1,791	2,036	11,682	13,483	245	1,801
Edison-Gower-Bell Telephone Company now represented by the Anglo-Portuguese Telephone Company	1,370	1,500	8,778	9,772	130	994
Total increase for the year					375	2,795

Western Counties and South Wales Telephone Company, Limited.

THE report of the directors for the year ending 31st December, 1887, contains the following:—The capital expenditure for the year ending the 31st December, 1887, has been £28,789 15s. 11d., making a total of £85,290 16s. 8d. to date. The gross revenue of the company for the year 1887 was £23,597 10s. 5d., against £15,406 11s. 1d. for the year ending 31st December, 1886. The working expenses for the year 1887 have been £6,693 8s. 3d., against £4,898 17s. 10d. for the year ending 31st December, 1886. Balance of net revenue account, £5,397 19s. 9d. Dividend of 6 per cent. on the paid up preference share capital for the year ending 31st December, 1887, £4,310 9s. 5d. The directors desire to state that although the progress of the company has been such as would have justified them in recommending the payment of a dividend on ordinary capital, they consider it best to defer doing so for this year. The opening of the company's system of trunk wires has necessitated a large amount of capital expenditure, at present practically unproductive, and the general revenue of the year has therefore to bear the burden of the preference dividend on the capital outlay. The growth of the business of the company for the past year has been very rapid; the number of subscribers to the company's exchange system having considerably increased, while there has been a satisfactory addition to the number of private line renters. It is the company's intention, should they find sufficient support to warrant them in doing so, speedily to open exchanges at Camborne, Cheltenham, Chippenham, Dawlish, Dorchester, Exmouth, Falmouth, Gosport, Great Malvern, Hereford, Pontypool, Redruth, Rugby, Salisbury, Sharpness Docks, Stroud, Swinton, Taunton, Tavistock, Teignmouth, Totnes, Tredegar, Truro, Weston-super-Mare, Winchester, Worcester. The company have received numerous inquiries for a connection between the principal towns in their district and the Metropolis. Should circumstances warrant undertaking the expenditure they will proceed to made the necessary arrangements. The foregoing remarks also apply to Birmingham, Manchester, Liverpool, and other important towns. To enable the company to carry out the contemplated extensions of business it will be necessary to raise additional capital, and the directors propose to create a further amount of £100,000 in 20,000 preference shares of £5 each.

United Telephone Company, Limited.—The directors have decided, subject to audit, to recommend, at the forthcoming general meeting, a dividend for the second half-year, ending April 30th, 1888, at the rate of 10s. per fully-paid share, and 5s. on the new shares, making, with the interim dividend paid on December 2nd last, a total dividend for the 12 months ending April 30th last of 15 per cent. Dividend warrants will be posted on July 3rd.

TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The number of messages passing over the lines of this company during the month of May was 4,437, estimated to produce £3,300, against 4,040 messages, producing £3,061 in the corresponding month of last year. The receipts for the month of February, estimated at £3,600, realised £3,666.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 31st May are £2,991, as compared with £3,498 in the corresponding period of 1887. The Feb uary receipts, estimated at £6,449, realised £6,625.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending June 1st, 1888, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,675.

The Eastern Extension, Australasia and China Telegraph Company, Limited. The receipts for the month of May, 1888, amounted to £40,586, compared with £36,495 in the corresponding period of 1887.

The Great Northern Telegraph Company, Limited. The receipts for May, 1888, £23 200; January 1st to 31st May, 1888, £108,400; corresponding months, 1887, £103,529; and of 1886, £100,930.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of May were £1,800, against £1,568 in the corresponding period of last year.

The Eastern Telegraph Company, Limited. The receipts for May, 1888, amounted to £49 003, compared Rith £48,037 in the corresponding month last year.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ending June 1st amounted to £3,376.

PROCEEDINGS OF SOCIETIES.

The Society of Telegraph-Engineers and Electricians.

AN ordinary general meeting of this Society was held on Thursday, May 31st, Mr. E. GRAVES, President, in the chair. The formal general business of the meeting having been transacted, a paper was read by Prof. SILVANUS THOMPSON on "The Influence Machine from 1788 to 1888."

On the 11th of June, 1788, a letter was read before the Royal Society addressed by Nicholson to Sir Joseph Banks, in which an instrument was described which was stated to be capable, by turning a winch, of producing an unlimited amount of electricity without friction and without communication with earth. As early as 1753 John Canton described an electrical apparatus in the Royal Society Proceedings, but his explanations were not at all clear; his ideas appeared to have grown up as he made his experiments, and the former were not well expressed; he observed, however, that all electrified bodies were apparently surrounded by an electrical atmosphere. Franklin and others had touched upon the subject, and opinions had been expressed based on mathematical theory. An Italian scientist had approached the subject from a third standpoint, and had found that a charge on a body behaved differently when another body was brought near it; he called this action "vindex," but for what reason did not appear. All the actions referred to were actually the same. About 1762 Wilcke made numerous experiments and practically described the electrophorous. Volta, in 1776—82, himself discovered this instrument. In 1780 Lichtenberg invented a double electrophorous, in which three plates were used, and by interchanging these in a manner described an accumulation of electricity could be obtained; this reciprocal action was the basis of the influence machine. In 1778 Erasmus Darwin (the author of the Botanic Garden) invented a mechanical arrangement for effecting the object. The Bennet "Doubler," an arrangement with three plates, invented in 1787, was really hardly an influence machine. In 1788 Cavallo devised a mechanical means of effecting the desired object. Cavallo found that it was impossible to construct a machine in which a charge was *not* found to accumulate after the machine had been worked; he concluded from this that some original charge must always exist. At the time the Nicholson "Doubler" was brought out it was criticised on the ground that the electricity, when it accumulated, would tend to spark across between the plates. In 1794 Read continued the subject and gave a curious narration in connection with it with reference to sanitary questions. Bohnenberger, in 1798, published a book which was literally full of descriptions of influence machines. Hachette and Desormes in 1798, and Ronalds in 1820, continued the subject, and in 1831 Belli devised an apparatus in which two fixed "field" plates were used; these plates were curved, and between them round plates at the end of a lever passed, the type of the machine being in fact absolutely the same as that of Thomson's "replenisher." Goodman in 1841, Svanberg in 1846, and Billet in 1851, also described machines. In 1860 Varley gave a full description in a patent specification of an influence machine. The name—influence—was actually introduced by Holtz, who devised numerous machines in 1865—67—83. In 1865—80 Toepler brought out his well known invention in which two discs were used. Holtz, it should be mentioned, abandoned the use of metallic carriers and used glass instead, the latter being electrified by means of points. Poggendorff improved the Holtz machine by doubling the plates. In the Holtz machines the parts had to be connected together in the first instance, as the machine was not self-exciting. Norton in 1866, Thomson in 1867—68, Carré in 1868, Kundt in 1868, Swendorff in 1871, Voss in 1880, and Wimshurst in 1881—88, continued the subject down to the present date. The machine of Thomson, called the "mouse mill," was, he (Prof. Thompson) pointed out, an almost exact analogue to the dynamo machine in that it possessed field exciters, an armature, commutator and brushes. Prof. Thompson then explained a theoretical diagram he had devised to explain all the actions of influence machines. Maxwell had suggested the addition to the machine of certain conductors to avoid internal sparking.

Kohlrausch had made numerous researches on the internal resistance and electromotive force of these machines. Two commercial applications had been suggested of the apparatus, viz., one by Dr. Oliver Lodge with reference to the condensation of fumes, and the other by Clark for gas lighting purposes. In conclusion he would point out that the first and last machines invented were both due to Englishmen and not to foreigners.

In the discussion which followed the reading of the paper,

Prof. AYRTON said that the history of the subject was really that of the same machine invented over and over again. The invention of Belli was in every feature similar to that of Sir William Thomson; he had asked the latter gentleman as to the development of the idea, and he was informed that he (Sir William Thomson) had devised it in entire ignorance of what had been previously done in the subject. He would ask Mr. Wimshurst whether the machine devised by him could be prevented from reversing, and also if he could give the reason why machines made by makers other than Mr. Wimshurst were not so good in their action as those of the inventor.

The discussion was then continued by Mr. MORDEY, Mr. WALTER and Prof. HUGHES.

Mr. WIMSHURST, in answer to Prof. Ayrton, said he had himself never found the machines to reverse: he could not answer the other question without personally examining the machines referred to.

Prof. SILVANUS THOMPSON, in replying, stated that the question of reversing depended on the proper use of combs and brushes, if the former were used no reversal would take place.

The meeting then adjourned till the autumn.

Physical Society, May 26th, 1888.

Mr. SHELFORD BIDWELL, F.R.S., Vice-President, in the Chair.

Mr. S. O. Roberts was elected a member of the Society.

The following communications were read: "Note on the Governing of Electromotors," by Profs. W. E. AYRTON and J. PERRY. In a paper read before the Society of Telegraph-Engineers in 1882 the authors deduced the conditions of self-regulation of electromotors for varying load when supplied either at constant potential or with constant current. The conditions involved "differential winding," *i.e.*, the use of a shunt motor with series demagnetising coils. With this arrangement fairly good regulation has been obtained, but owing to want of economy the methods have not been developed further. Since then another arrangement, in which a simple shunt motor is used and a few accumulators placed in series with the armature, has been devised for working in a constant current system. By means of a suitable switch the accumulators can be charged when the motor is at rest. On the assumption that the E.M.F. of motors is given by $E = n\,(p + t\,z)$ where n = speed, z = number of turns on magnets and p and t are constants, it is shown that the speed at which a motor will govern is given by $n = \frac{z + a + a'}{t}$ and the constant current $C = \frac{e - n\,p}{a + a'}$ where s and a are the resistances of the shunt and armature respectively and e and a' the E.M.F. and resistance of the accumulators. Since a and a' may be small and $n\,p$ not large, the value of e need not be great to give a considerable value for C, and thus only a small number of accumulators will be required.

"On the Formula of Bernoulli and Haecker for the Lifting Power of Magnets," by Prof. S. P. THOMPSON, D. Sc., read by Prof. PERRY. The formula referred to are $P = a\,\sqrt[3]{W^2}$ and $P = a\,\sqrt[3]{W^2}$ respectively, where P = lifting power, W = mass of magnet, and a a constant depending on the material and shape of the magnet. These formulæ the authors show are equivalent to saying that the lifting power of magnets in which the magnetic induction, B, has been carried to an equal degree, is proportional to the polar surface, and that Haecker's coefficent, a, is proportional to B^2 through the surface. Assuming the induction uniform over the surface, it is shown that $P = \frac{1}{8\pi}\,B^2\,A$ where A = area of surface, and this gives a very convenient method of determining B from measurements made upon the pull exerted at a given polar surface. If P be measured in kilos and A in square cms. the formula for B becomes $B = 5{,}000\,\sqrt{\frac{P}{A}}$, and if the measurement be made in lbs. and inches the constant becomes 1,317. It will be readily seen that the greater power of small magnets in proportion to weight does not require for its explanation the sometimes alleged fact that small pieces of steel can be more highly magnetised than large ones, for if B be the same, the lifting power will be proportional to the polar surface, and not to weight, and hence must necessarily be greater relatively to weight in small magnets. In the case of electro-magnets for inductions between 6,000 and 16,000, between which the permeability, μ, is approximately given by $\mu = \frac{16{,}000 - B}{3{\cdot}2}$ the lifting power is shown to be

$$P = A\left(\frac{3{\cdot}2\,s\,i}{s\,i + 2{\cdot}56\,l}\right)^2$$

where P is in kilos, A in square centimetres, $s\,i$ = ampère turns and l = mean length of the magnetic circuit.

"Experiments on Electrolysis," Part II., Irreciprocal Conduction,* by Mr. W. W. HALDANE GEE, B. Sc., and Mr. H. HOLDEN, B. Sc. An abstract was read by the Secretary. The authors have observed that when strong sulphuric acid is used as an electrolyte, the electrodes being of platinum, that the decomposition nearly ceases, if, by decreasing the resistance in circuit it is attempted to increase the current beyond a certain maximum. When this condition (called the insulating condition) is arrived at, reversing the current immediately restores the conductivity. Experiment shows that the current density is an important factor, and that the composition, viscosity and temperature of the electrolyte as well as the previous history of the electrodes have considerable influence on the current density at which the insulating condition occurs. The seat of the insulating layer is found to be at the anode, and the authors believe it due to very concentrated acid formed around the electrode, whose specific resistance is very high. Experiments were also made with carbon and gold electrodes, and phosphoric acid, caustic potash, soap and sodium benzoate were used as electrolytes, the results of which seem compatible with the concentration hypotheses above stated. The paper contains an historical and critical account of allied phenomena, and tables expressing the numerical results obtained by the authors are given.

NEW PATENTS—1888.

7655. "Improvements in and connected with underground conductors of electricity." R. E. B. CROMPTON. Dated May 25.

7679. "Improvements in electric lamps." J. G. SOWERBY and C. J. CHUBB. Dated May 25.

7692. "Improvements in the manufacture of screws, screw rivets, bolts, terminals, and other fittings used in connection with electrical appliances." C. K. FALKENSTINE and J. J. VARLEY. Dated May 25.

7696. "Improvements in incandescent electric safety lamps." T. COAD. Dated May 25.

7720. "Improvements in electric tell-tales for checking watchmen and other similar purposes." H. BOARDMAN. Dated May 26.

7748. "An electric motor for clocks, watches, and other similar apparatus." L. HOPPE and G. HOPPE. Dated May 26.

7750. "Improvements in electric arc lamps." J. DULAIT. Dated May 26.

7761. "Improved method of applying electricity to a general system of traction." C. B. BURDON. Dated May 28.

7805. "Improvements in the method of and apparatus for the production, transmission, and distribution of electric currents." H. J. ALLISON. (Communicated by C. E. Fritts, United States.) Dated May 29. (*Complete.*)

7826. "Improvements in galvanic generators." H. B. COX. Dated May 29. (*Complete.*)

7848. "Improvements in or relating to indicators for alternating electric currents." W. P. THOMPSON. (Communicated by G. Westinghouse, jun., United States.) Dated May 29. (*Complete.*)

7849. "Improvements in or relating to apparatus for detecting and locating faults in alternate electric circuits." W. P. THOMPSON. (Communicated by G. Westinghouse, jun., United States.) Dated May 29. (*Complete.*)

7850. "Improvements in or relating to alternate current electric distribution." W. P. THOMPSON. (Communicated by G. Westinghouse, jun., United States.) Dated May 29. (*Complete.*)

7851. "Improvements in switches for electric circuits." W. P. THOMPSON. (Communicated by G. Westinghouse, jun., United States.) Dated May 29. (*Complete.*)

7852. "Improvements in or relating to central station apparatus for system of electric distribution by alternate currents." W. P. THOMPSON. (Communicated by G. Westinghouse, jun., United States.) Dated May 29. (*Complete.*)

7853. "Improvements in or relating to storage batteries." W. P. THOMPSON. (Communicated by C. D. P. Gibson, United States.) Dated May 29. (*Complete.*)

7876. "Improvements in electric batteries." B. WILLCOX. (Communicated by B. A. Abakanowicz and A. d'Arsonval, France.) Dated May 29.

7901. "Improvements in the construction of electro-medical, and other magnets." J. J. HORNE. Dated May 30.

7910. "Improvements in holders for incandescent lamps." F. T. SCHMIDT. Dated May 30.

7916. "Improvements in transmitting written or other characters, figures, drawings, plans or the like, and also indicating and recording the indications of registering instruments by electricity and in apparatus therefor." T. O'BRIEN. Dated May 30.

7941. "Electromotive fountains and engines." H. C. B. SHALDERS and A. J. THORMAN. Dated May 31.

7977. "Improvements in the mode of filling secondary battery plates." H. G. MORRIS and P. G. SALOM. Dated May 31. (*Complete.*)

7998. "Improvements in and relating to shades and reflectors for incandescent electric lamps." F. HOLMAN. Dated May 31. (*Complete.*)

* Irreciprocal conduction is said to occur if a reversal of the direction of a current causes any change in its magnitude.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1887.

2563. "Improvements in electrical primers." G. STUART. Dated February 18. 8d. This invention has for its object improvements in electrical primers. Relates to the construction of electrical fuses for use with axial vented guns, more especially rapid fire guns. The claims are 3 in number.

2598. "Improvements in electric gas-lighters." T. P. HEWITT. Dated February 19. 8d. The object of the invention is to provide a cheap and efficient mechanism for actuating electric gas-lighters, which may be easily and silently operated. The claims are 2 in number.

2819. "An improved method of combining and arranging apparatus operating electric lamps for signalling and other purposes." H. NERLINGER. Dated February 23. 8d. Consists in a method of showing varying combinations of electric lights, more especially for the purpose of signalling, two sets of keys one above the other being used, connected by vertical rods and transverse levers so that by pressing upon one of the upper keys the electrical contacts are so changed that the current ceases to pass through the artificial resistance and passes through the proper contact pieces connected with the wires and through them to the proper lamps and to the generator, the lamps which come into action giving a signal every time the key is pressed and ceasing to show when the pressure is removed. There is 1 claim.

2825. "Improvements in or applicable to dynamo-electric machines." J. G. STATTER. Dated February 23. 11d. Consists chiefly in providing a magnetic field of the requisite intensity and making this intensity the same over the whole extent of this magnetic field by removing portions of the sides of the pole pieces which embrace the armature at places where the intensity of the magnetic field is greatest, the position of these places varying somewhat with the form of field magnets and pole pieces employed, or the inner sides of the pole pieces are shaped to such a curve as shall give the desired result, or wrought iron cores may be employed in the field magnets with cast iron pole pieces and allowing the wrought iron to reach the inner surfaces of the pole pieces at places where it is desired to keep up the intensity of the magnetic field. The claims are 4 in number.

3158. "Improvements in machines for giving currents of electricity on the insertion of a coin, token, or the like." P. EVERITT. Dated March 1. 8d. The inventor constructs the machine with a suitable case containing a galvanic, a primary, or a secondary battery, accumulator, or the like with or without an induction coil and capable of giving a current which can be transmitted to handles. In order to cause the current to be transmitted to a pair of handles, a connection is made between the handles and the generator used; one handle can be permanently connected whilst the other is connected only on the insertion of a coin, token, or the like. There is 1 claim.

4116. "Improvements in electric incandescent lamps and in the method of manufacturing the same." A. F. ST. GEORGE and C. R. BONNE. Dated March 18. 8d. Claims:—1. The method of construction of a filament, thread, wire, pencil or rod of carbon of tubular cross section by electrically heating the platinum, substantially as and for the purposes set forth and described. 2. The combination of a carbon filament, thread, wire, pencil or rod within a receiver made of glass having one or more apertures closed by means of one or more discs or diaphragms of metal foil or sheet secured as described and through which the electric leading wires pass and to which they are secured as described and from which receiver the air is exhausted, substantially as and for the purposes set forth. 3. The method of securing the leading wires to the metallic foil diaphragm or diaphragms by means of the paste herein described, substantially as and for the purposes set forth. 4. The method described of securing to and insulating from the metallic diaphragm one or more of the electric leading wires by means of the paste described. 5. The method described of sealing the glass receiver at one or more of its apertures by means of the metallic foil discs or diaphragms secured thereto as described in order to preserve a vacuum within the receiver, as and for the purposes described.

4225. "Improvements in electricity meters, parts of which improvements are applicable to dynamo-electric generators and motors." G. HOOKHAM. Dated March 21. 1s. 1d. Consists essentially of an electro-motor with constant or nearly constant field, the armature carrying the current to be metered, and an electric brake consisting of a mass of metal in the form of a disc cylinder or other figure of rotation rotating in a magnetic field in such a manner as to have "eddy" or so called "Foucault" currents generated in it. When all other work done by the motor is negligible compared with that done against "eddy" currents, the speed of rotation of its armature is directly proportional to the armature current. The claims are 10 in number.

4369. "Improvements in instruments for detecting and measuring electric currents." P. JOLIN. Dated March 23. 8d. Relates to improvements in instruments commonly called galvanometers as now constructed with a moving coil on the principal of "Thomson's Syphon Recorder." The claims are 12 in number.

4545. "Improvements in electrical measuring and indicating apparatus." C. D. ABEL. (Communicated from abroad by the firm of Siemens and Halske, of Berlin.) Dated March 26. 8d. Relates to the measuring and indicating of quantities of any kind, such as the difference of potential between two points of an electrical circuit, the height of a water level, the velocity of a stream, &c., the object of the invention being to render such indication and measurement easy and reliable without the employment of sensitive measuring instruments, which would require the attendance of experts and careful adjustments from time to time. This object is effected by the use of two parallel electrical circuits supplied from one and the same source of electricity. In the one circuit (termed the "regulating circuit") apparatus are introduced that serve to maintain the strength of current constant in the second circuit (termed the measuring circuit). This is effected in the case of a constant difference of potential between the points where the two circuits branch off, by causing a decrease of resistance between two points of the measuring circuit, to result in the production of an equal increase of resistance between two other points of this circuit, so that the total resistance in the measuring circuit remains constant. In the case of a variable difference of potential, on the other hand, it is effected by causing the decrease or increase of the difference of potential to result in a proportionate decrease or increase of the total resistance of the measuring circuit. The claims are 4 in number.

4635. "Improvements in and relating to telephonic and telegraphic call apparatus." C. L. BAKER and F. BRYAN. Dated March 29. 8d. Claims:—1. A telegraphic or telephonic individual call system, constructed, arranged and operated substantially as and for the purposes described and as illustrated by the drawings. 2. In an individual call system for telegraphic and telephonic purposes, the combination of a locking and releasing device with clock work, synchronous contact cams, and an electromagnetic system for operating the locking and releasing devices; all constructed, arranged and operated substantially as described with reference to the drawings. 3. In an individual call system for telegraphic and telephonic purposes; the combination with the locking device of a contact cam and a contact spring operating to put the local branch line or local circuit into or out of connection with the system and constructed and arranged substantially as described.

4714. "Improved electrical signal bell apparatus for stations communicating with a single wire telegraphic circuit." F. A. AMORIC. Dated March 29. 8d. This invention relates to a signal bell apparatus for use on all stations communicating with a single wire telegraphic circuit, whereby a person at any one of the stations can signal to another of the stations, without sounding the signals of the other station. It also indicates at all the stations of the line which parts are occupied, so that the parts not occupied may be utilised for passing signals. The claims are 8 in number.

CORRESPONDENCE.

The Electrolysis of Mercury by the Action of an Alternating Current of Electricity.

Perhaps it will be of interest to some readers of your valuable paper to know of the peculiar behaviour of two mercury electrodes placed a short distance apart in dilute sulphuric acid, when an alternating current of electricity is passed from one electrode to the other through the dilute sulphuric acid. As soon as a current is caused to flow the mercury becomes agitated and presents a beautiful wavy appearance on its surface, which increases in its agitation as the current strength increases. The mercury at the same time being attacked by the acid forming an insoluble sulphate, rises with the hydrogen which is liberated at the surface of the mercury in a cloudy form, and slowly falls to the bottom of the cell. This peculiar phenomenon is of great scientific interest, as this sulphate is formed in proportion to the current passing, consequently the mercury loses in weight in the same proportion. We made these discoveries in the course of an extended series of experiments to overcome the difficulty of metering alternating currents. Owing, however, to many mechanical difficulties in the use of mercury, the idea to use this as a meter was abandoned. Further researches resulted in a successful issue, and we hope to shortly publish an account of the working of our meter.

Lowrie-Hall.

Galvanic Belts.

I should be glad if you could find room in your valuable paper for these few remarks concerning Harness's electropathic belt.

If Mr. Harness would let us know what E.M.F. is given from his belt that cures all diseases, it would be

as well to do so. Take the resistance of the human body, according to Dr. Stone, at 2,000 or 3,000 ohms, it would require 20 or 30 volts to be of any appreciable use to the patient, and then he must be immersed in a salt water bath, and the current applied in a scientific manner. If Mr. Harness will, before he attempts to write to the electrical papers, study Ohm's law and then the science of physiology, he would not attempt to sell a belt that cures diseases without he could prove it in a scientific institute. I am very glad to see a member of the Society of Electrical Engineers has replied to Mr. Harness in the way in which he did.

F. J. Beaumont, *A.S.T.E. & E., M.S.C.I., M.B.A.S.*

The Mordey Dynamo.

Seeing the illustrations of above in last week's number of the ELECTRICAL REVIEW, I wish to state the form of field is eight or nine months' old. I have a model machine, about 20 lbs. weight, which I could show either to you, Sir, or to Mr. Mordey. I append a few particulars :—The field is a wrought iron cylinder with a spindle screwed through the centre, on each side of this cylinder is screwed a cast-iron piece with four arms or spokes and between these is wound a coil of wire on a brass spool to excite this revolving field magnet. The gunmetal bearings being circular serve to carry this field and a series of electro magnets which are the whole length of field ; these electro magnets being screwed round the circular bearings support the whole machine. Revolving the field the arms or spokes pass the ends of the electro-magnets when the field is excited by two bichromate cells. I can light two small incandescent lamps by giving a sharp twist by hand. I have no rings or collectors to my excited field, the ends being coupled direct to the battery, the ends of the armature coils or bobbins are taken to the external circuit (lamps). When I made it I anticipated getting a commutatorless self-exciting dynamo, but for want of time I did not proceed further with it.

H. Jones.

June 4th 1888.

[When this letter arrived we felt certain that poor Mr. Mordey's new dynamo had been anticipated, and that his years of thought and labour had all been wasted. After perusal we have come to the conclusion that the field is still open to him.—EDS. ELEC. REV.]

Electric Traction.

The letters in your issues of June 1st, in reply to my communication of the previous week, do not in any way explain the report of Messrs. Frederick Walker and Hyde. In the first letter of your correspondence column, Mr. Jarman, the inventor, says the inclines are 1 in 30, while, on the next page, the consulting engineers say they are 1 in 20. I presume they are not both correct. They do not question my figures as to the quantity of current used for each journey. My contention is that the fact of the return journey taking some minutes longer than the outward one proves that the figures, or the instruments, were incorrect. Anyone who has the most casual acquaintance with electro-motors knows that if you reduce the speed the current increases out of all proportion to the extra amount of work done. That there was an extra amount of work done, is, as I said before, proved by the difference of time required to do it in, and that the speed per hour was less in the return journey.

I have before me an article by Frederick Walker, which was awarded the prize in a mechanical contemporary, in which he bases his calculations upon a car weighing 1¾ tons, accumulators and motors 1½ tons, and passengers 2 tons, a total of 5¼ tons ; and he speaks of no gradient exceeding 1 in 80, to start up which it would require a current of 69 ampères at 118·8 volts, say 8,197 watts (though he says 8,300 watts). This trial must have been a revelation to him, for the car which weighs with motor and cells quite 2 tons more started on a gradient of 1 in 20 with only 9,798 watts.

I would like to ask the date of this trial, as we should be able to judge from the state of the road the amount of work done.

I think this matter is of sufficient interest to warrant asking your indulgence for trespassing on your space, unless you think with the inventor (which I am sure you do not), as stated by him in the ELECTRICAL REVIEW of May 20th :—"As to the engineering point of view, well, there is little to consider."

I must congratulate Messrs. Walker and Hyde upon their resolve to give an accurate report *when required to do so* ; and as they were good enough to offer me some advice, I will give them some in return—that is not to send any more reports to a trade paper containing statements which border on the impossible without giving the figures upon which they are based, as the readers of a technical paper, unlike most of the readers of the daily press, as a rule understand something about the questions discussed therein.

William Brand.

June, 5th, 1888.

Theatre Lighting.

Referring to your note upon the article on theatre lighting contained in *La Lumière Electrique*, I should like to set your readers right as to the true position of the electric light in London theatres.

First taking the matter contained in M. Hornimann's article. He begins with the Savoy. The total lamps are 1,779 and not 1,158. Stage, 1,316 (not all used at the same time), and 313 in the dressing rooms, &c. ; and not 824 and 220 respectively. Then the dynamos are three Siemens direct, and not six alternating. There are *two* arc lamps outside, which are in parallel with one of the incandescent circuits, and do not have a special machine to themselves. There are three steam engines of a total horse-power of 60 and not 130.

The Olympia I shall not discuss, as it is no more a theatre than the other exhibitions.

The data given for the Prince's, or, properly, Prince of Wales's, is correct, with the exception of there being 416 lamps instead of 350, and that the current is obtained from the Grosvenor Gallery, although there is private plant. There is very little electric light on the stage.

The Lyceum is given as having the electric light, but it has none whatever.

The Empire is passed over in a few words, it being stated to have 120 lamps ; as a matter of fact it is entirely lit, having a total of 1,036 lamps.

The Haymarket is the other theatre mentioned as being lit, but it only has about 120 lamps, all in the auditorium.

Now to take the theatres of which no mention is made.

The Criterion is entirely lit by electricity, having in all about 700 lamps supplied by three Edison machines.

Terry's is entirely lit by about 400 lamps ; current supplied from the Grosvenor Gallery.

The Gaiety is entirely lit, the total lamps being about 450 ; current from Grosvenor or from two Goolden-Trotter dynamos.

The Oxford Music Hall is entirely lit by 530 lamps ; current from the Grosvenor.

The Adelphi is now being entirely lit.

The Alhambra has the stage partially and the auditorium entirely lit by two Edison machines and 108 accumulators. Total lamps 424.

The Pavilion Music Hall has 300 lamps in the auditorium run from two Edison machines.

Thus we see there are in London five theatres and two music halls which are entirely lit by the electric light, only one theatre and one music hall being mentioned in *La Lumière Electrique*. There are two theatres and two music halls of which the auditoriums are entirely lit, but the stage only partially or not at all, of which the two theatres only are mentioned.

Ernest George Tidd.

June 5th, 1888.